POWER PLANT ENGINEERING

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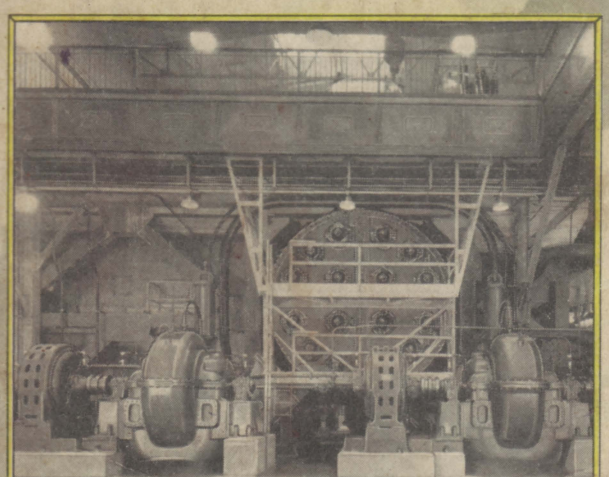
ISSUED SEMI-MONTHLY

CHICAGO, MARCH 1, 1931

VOLUME XXXV
NUMBER 5

At Ashtabula . . .
Three More Worthington Condensers For Cleveland



One of the three Worthington 57,000 sq. ft. Single-Pass Surface Condensers at the Ashtabula Plant. This plant was designed by the Engineering Staff of the Cleveland Electric Illuminating Company.

IN selecting Worthington Condensers and Auxiliary Equipment for the new plant at Ashtabula, Ohio, the Engineering Staff of the Cleveland Electric Illuminating Company was guided by the successful performance of the seven Worthington units in their Lake Shore and Avon Plants.

The three Worthington 57,000 sq. ft. Single-Pass Condensers at Ashtabula embody the exclusive Worthington "folded tube layer" design. They are representative products of Worthington's experience and intensive work in the development of improved condenser design.

Address the Condenser Division at the Harrison, N. J., Works for information on the advantages offered by Worthington equipment.

WORTHINGTON PUMP AND MACHINERY CORPORATION

Works: Harrison, N. J. Cincinnati, Ohio Buffalo, N.Y. Holyoke, Mass.

Executive Offices: 2 Park Avenue, New York, N.Y.

GENERAL OFFICES: HARRISON, N. J.

District Sales Offices and Representatives:

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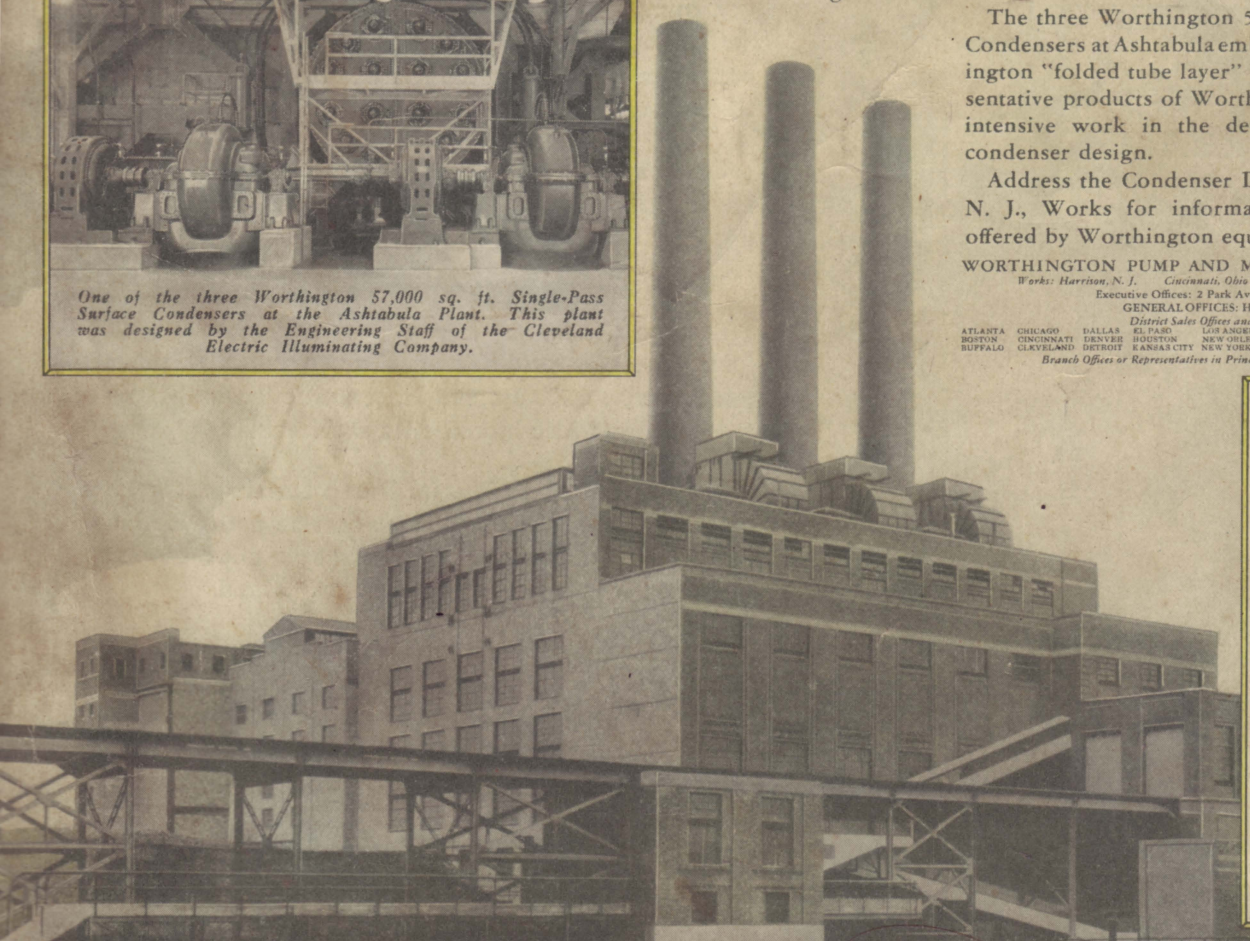
Branch Offices or Representatives in Principal Cities of all Foreign Countries



PUMPS
All Sizes... All Types
For All Services
Any Capacity... Any Pressure
COMPRESSORS
Stationary and Portable
CONDENSERS
and Auxiliaries
DIESEL ENGINES
GAS ENGINES
FEEDWATER HEATERS
WATER, OIL and GASOLINE METERS
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ROCK DRILLS
AUTOMATIC HEAT TREATING MACHINES FOR DRILL STEEL
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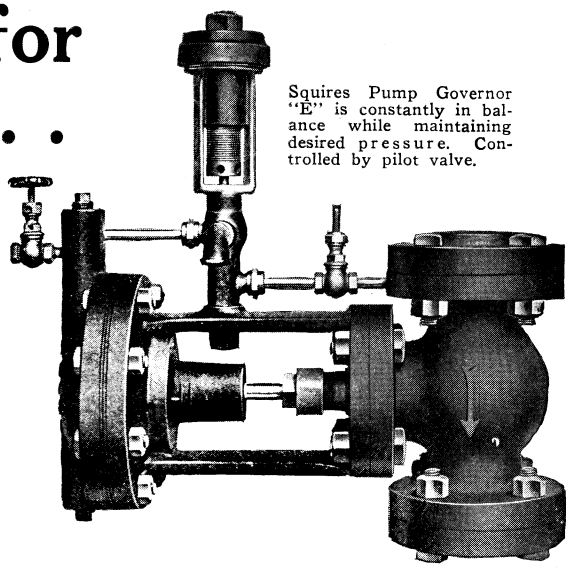
DRILL STEEL
ACCESSORIES
CHROMIUM PLATING

Literature on request

WORTHINGTON

The answer to the call for better pump control . . .



Squires Pump Governor "E" is constantly in balance while maintaining desired pressure. Controlled by pilot valve.

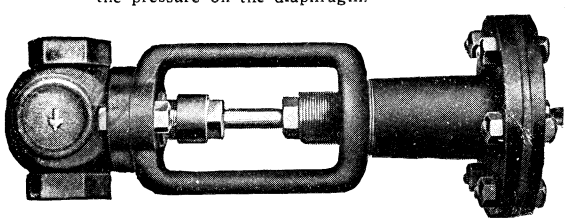
Other Genuine Squires *Steam Specialties*

Specialists for over 30 years on steam problems make available a fund of experience which is at your service to call upon. Write us about applications of any of these Squires Specialties:

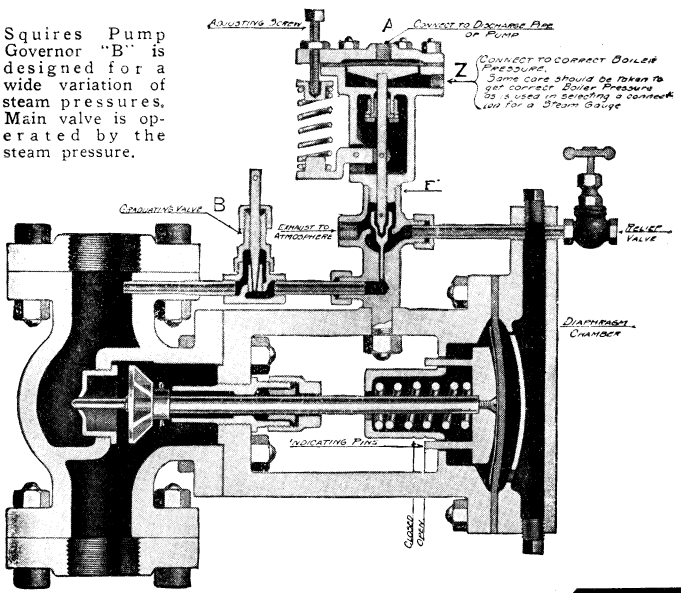
Standard Genuine Squires Steam Trap
New Genuine Squires Steel Trap
Air Trap
Blast Trap
Gasoline Trap
Reducing Valve
Boiler Feed Water Controllers

SQUIRES Pump Governors

Below, Squires Pump Governor "H." The pump pressure is automatically regulated by the pressure on the diaphragm.



Squires Pump Governor "B" is designed for a wide variation of steam pressures. Main valve is operated by the steam pressure.



Three classes of Pump Governors are made by Squires to fulfill modern requirements and master every pumping condition. Their simplicity, durability and economy result in constant pressure service that continues throughout the lifetime of the pumps which the governors control.

Squires Class "E" Pump Governor carries a constant feed water pressure on any type of boiler feed pump. It can be installed in either horizontal or vertical lines and has very few wearing parts.

Squires Class "H" Pump Governor maintains uniform pressure for boiler feeding, circulating pumps, tank pumps, etc. Its simple construction and removable seat and disc increase its serviceability.

Squires Class "B" Excess Pump Governor, for high pressure power plants, marine service and with hand regulation on boilers, is controlled by a pilot valve and governed by the pressure to be maintained.

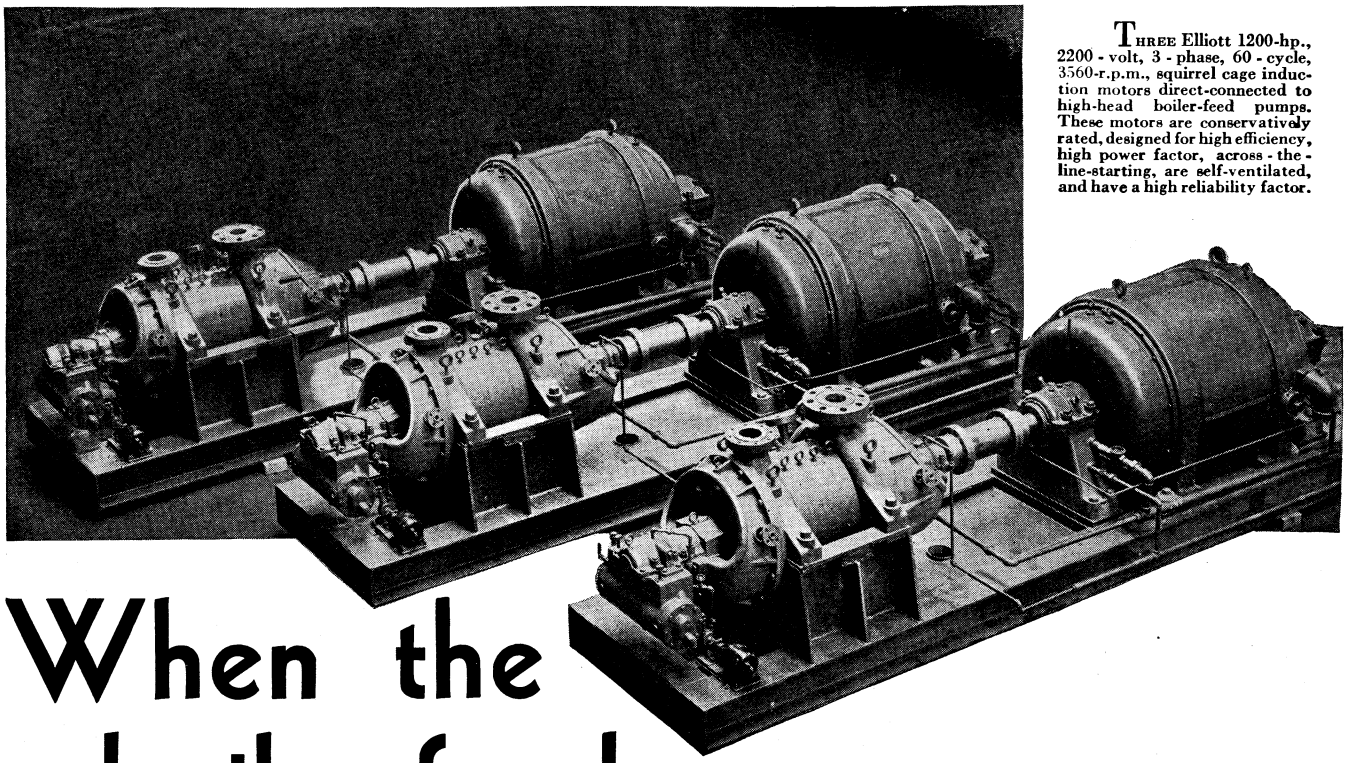
Send for full information on the Squires Pump Governors and the other Squires Specialties for increasing plant efficiency. Catalogue E on request.

Insist on the Genuine Squires

Steam Specialties

THE C. E. SQUIRES COMPANY

E. 40TH ST. & KELLEY AVE., CLEVELAND



THREE Elliott 1200-hp., 2200-volt, 3-phase, 60-cycle, 3560-r.p.m., squirrel cage induction motors direct-connected to high-head boiler-feed pumps. These motors are conservatively rated, designed for high efficiency, high power factor, across-the-line-starting, are self-ventilated, and have a high reliability factor.

When the boiler-feed pump goes *high speed*

The boiler-feed pump is the heart of the power plant. As steam pressures have gone up in the modern station, boiler-feed pump speeds have correspondingly increased, and the *dependability* of the pump and of its drive is more important than ever.

When a very well known public utility wanted high-speed squirrel cage induction motors to drive boiler-feed pumps in a new 1200-lb. station, they came to Elliott. After most careful investigation, they purchased Elliott motors.

The awarding of these motors to the Elliott Company was in recognition of their long experience in the pioneering and development of large high-speed motors, many of which have been in successful service from 12 to 15 years.

Elliott motor designers and builders have equally adequate experience in building all sizes and types of high-speed motors, slow-speed motors, motors for particularly difficult drives, and for special applications.

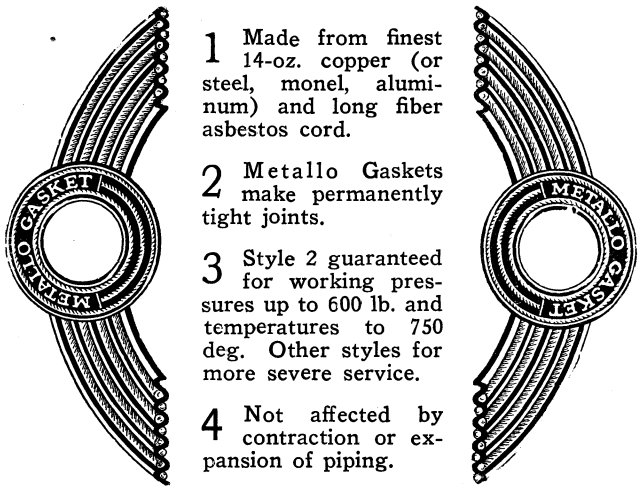
When you want motors designed with special care and built for rugged dependability, call on Elliott.

L-667

ELLIOTT COMPANY
PITTSBURGH, PA.
Electric Power Department
RIDGWAY, PA.
District Offices in Principal Cities

ELLIOTT MOTORS

NOTE these POINTS!



1 Made from finest 14-oz. copper (or steel, monel, aluminum) and long fiber asbestos cord.

2 Metallo Gaskets make permanently tight joints.

3 Style 2 guaranteed for working pressures up to 600 lb. and temperatures to 750 deg. Other styles for more severe service.

4 Not affected by contraction or expansion of piping.

"The Gaskets that Stay and Pay"

Metallo Gaskets have won the approval of engineers wherever they have been used. Lowering cost of maintenance and saving labor by making a sure joint that will not leak or blow out, the Metallo Line always proves itself a paying investment. Write for Metallo handbook.

Metallo Gasket Co., New Brunswick, N. J.

Write now for information on *Rod-Packing Economy!*

Now comes the flexible packing that fits into the gland and forms a bushing-like seal that will not harden, bind or allow leakage. Investigate the economies of

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THE DARCOID CO., Inc.
179 Christopher St., New York

Specify
Established 43 years.

The Complete

CRANDALL

Packing Service

Let our experienced engineers furnish your plant with packings that give satisfaction and meet all requirements. Write for our new book.

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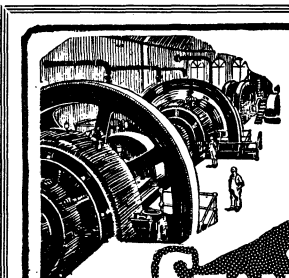
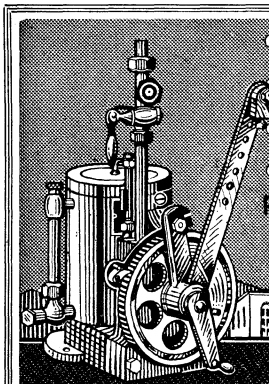


Reduce Friction

Standardize on
STANDARD OILS
AND GREASES
Standard Oil Company
(INDIANA)
910 So. Michigan Blvd. Chicago



ROCHESTER AUTOMATIC LUBRICATORS

PROVIDING AUTOMATIC LUBRICATON FOR THE CYLINDERS OF ENGINES, PUMPS AND COMPRESSORS

GREENE, TWEED & CO.
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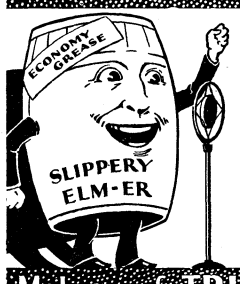
Factory: Newark, N. J.

ECONOMY GREASE
A Lubricant of the Better Grade



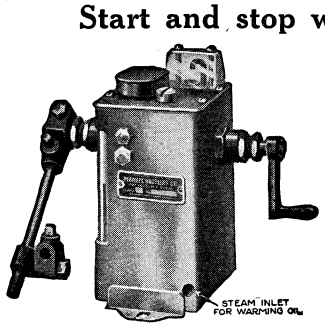
Eliminate that lubrication problem with ECONOMY GREASE! Will not gum up, harden or dry out. Unaffected by climatic conditions . . . . . .

ECONOMY LUBRICATING CO.
CHARLESTOWN, MASSACHUSETTS
MFRS. AGENTS' SALES OFFICES
NEW YORK · CHICAGO

Makers of TRUE BLUE boiler treatment

MANZEL FORCE FEED LUBRICATORS

Start and stop with the engine



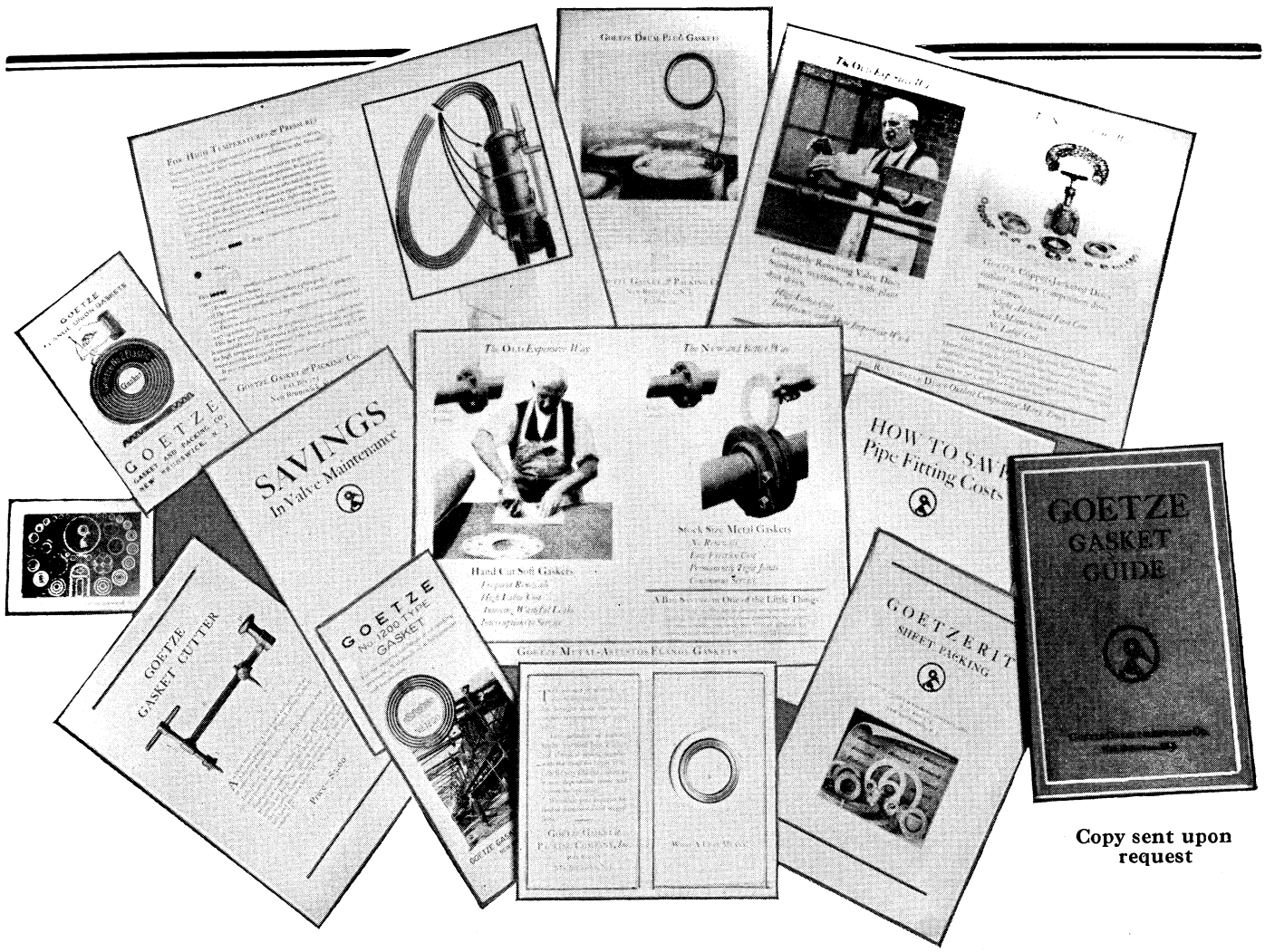
30 Days' Free Trial

Regardless of engine speed, Manzel Lubricators supply just the required amount of oil,—no more or no less. A simple adjustment permits any flow of oil desired.

Manzel Lubricators are furnished with one or more feeds,—also with two compartments for feeding two kinds of oil.

Write for Catalog No. 430.

Manzel Brothers Co.
327 Babcock St.
Buffalo, N. Y.



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For Modern Power Plant and Industrial Practice *Specify*

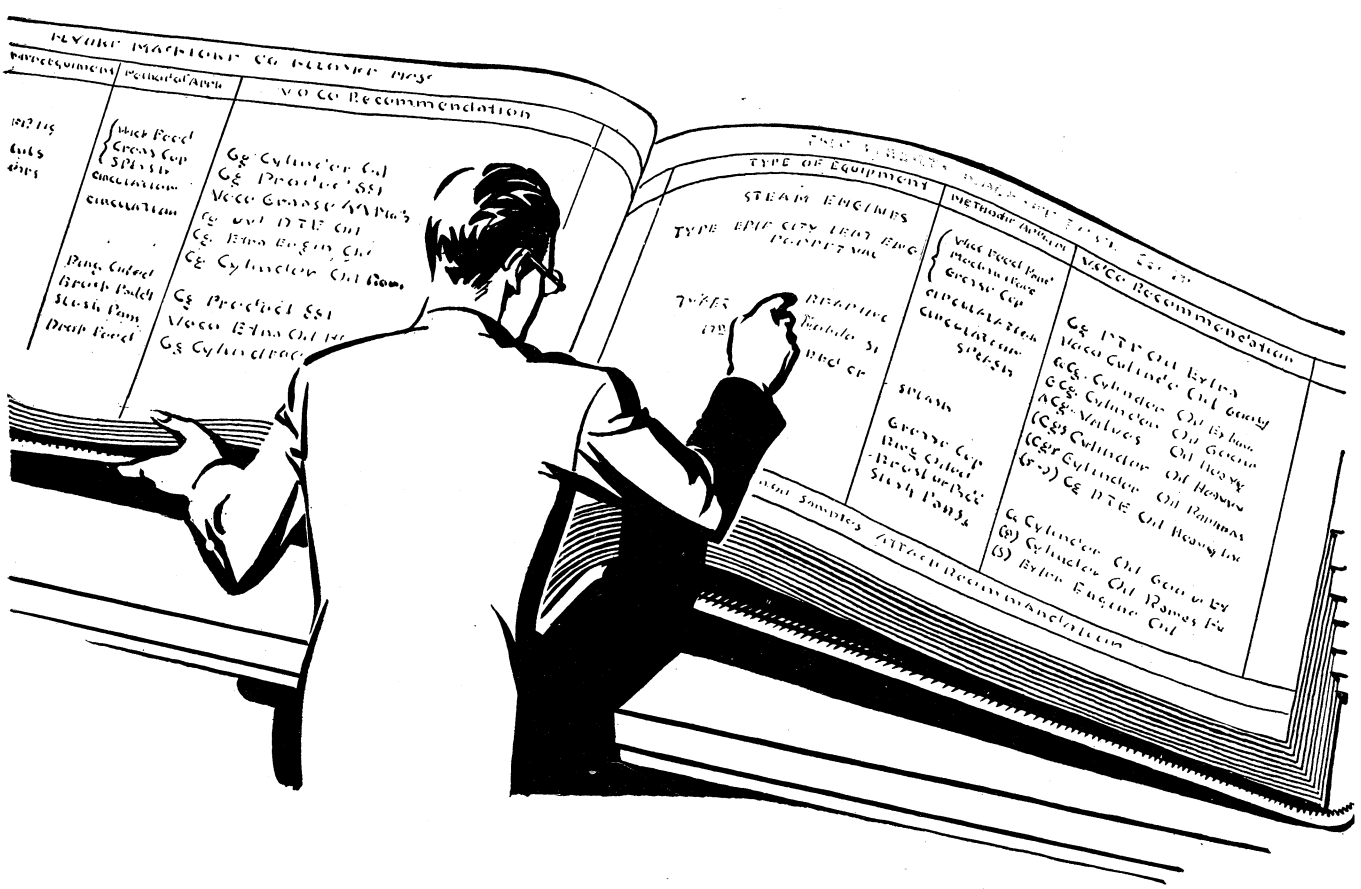
Our Standard Products are:

No. 1 Plain Corrugated Metal
No. 2 Corrugated Metal with Asbestos
No. 3 Corrugated Metal Asbestos with Graphite Cement
Triumph Type—Metal Shell—Asbestos [a] *Single Jacketed* [b] *Double Jacketed*
French Type
Inside Open Type
Cylinder Head Gaskets
No. 1200 Type Metal Asbestos
Seamless Solid Rings
Washers for any purpose
Boiler Gaskets for Handholes, Manholes, and Tube Caps
Lead Gaskets
Drum Plug Gaskets
Goetzerit-Compressed Asbestos Valve Discs
GOETZE PACKINGS FOR STUFFING BOXES
Flexible Metallic Packing, Rex Metallic Packing, Braided Asbestos Packing
Special Packings and Gaskets Stampings

GOETZE GASKETS

GOETZE GASKET & PACKING CO., Inc.
17 Allen Ave.
New Brunswick, N. J.

24,000



GARGOYLE

Lubricating Oils

The world's quality oils for plant lubrication

EXPERTS

helped compile this book to help you

THE only book giving complete recommendations of lubricants for the machinery and engines of world-wide industry—is the Vacuum Oil Company's handbook, "Engine Builders' Book." Constant revision keeps it up-to-date. It contains the practical experience and technical knowledge of many thousand engineers, in the following groups:

The engineers of leading engine and machinery builders
Vacuum Oil Company engineers servicing world industry
Engineers in all kinds of industrial plants.

In a recent survey of American industry, 47% of important industrial men interviewed, reported unsolved lubrication problems. If *your* plant has one or more of these unsolved problems, or if you wish to avoid having them, the information in this book can help you. Every Vacuum representative carries a copy of this book. (It is not for general distribution.)

Twenty-four thousand heads are better than one. Give them an opportunity to serve you.

VACUUM OIL COMPANY

Headquarters: **61 Broadway, New York • Branches and distributing warehouses throughout the world**

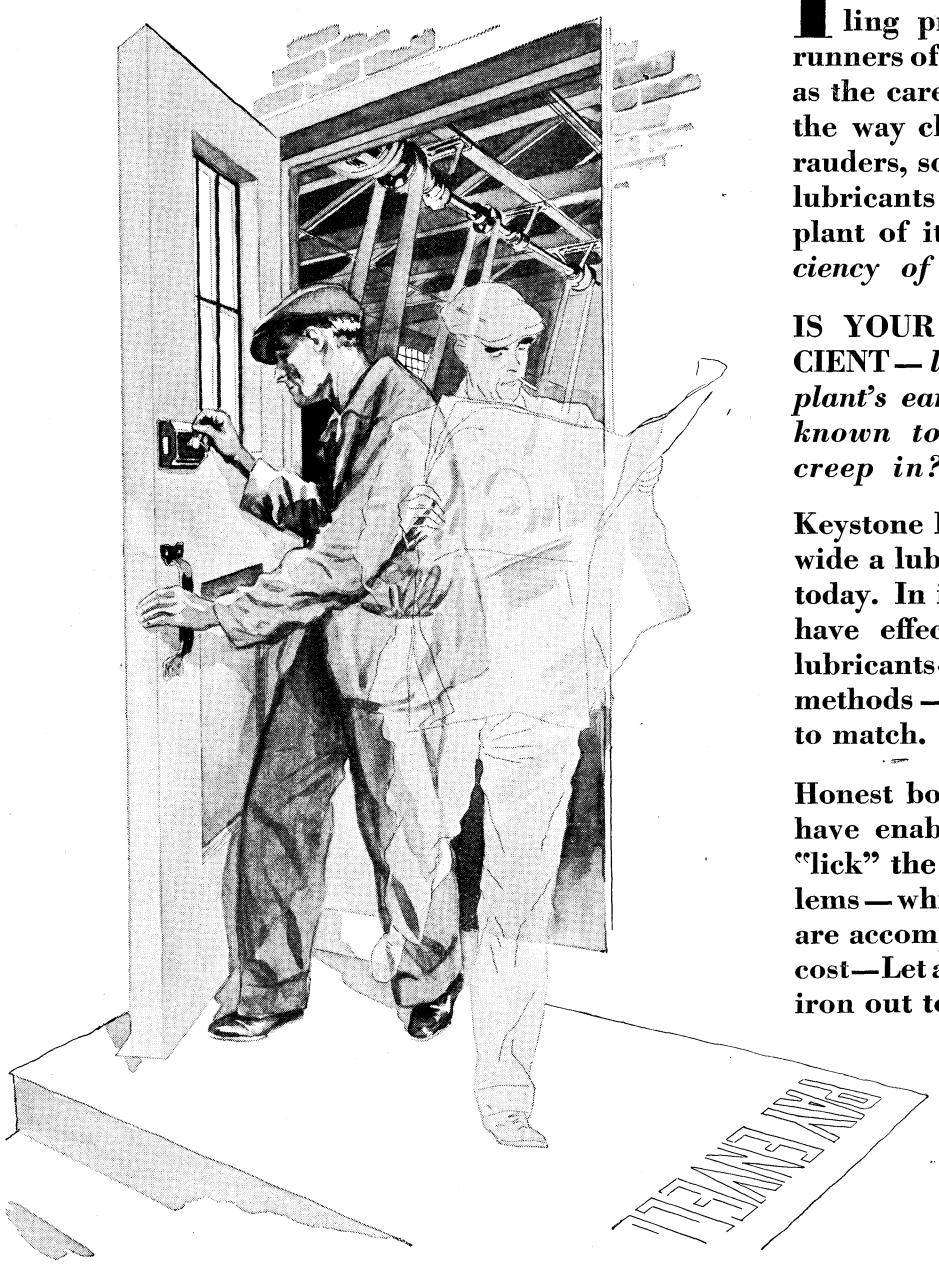
Careful

"Bill Maintenance" has two sides to him — two characters. He can either be a conscientious worker, ever watchful of your property — or through carelessness, be a constant menace.

Or Careless?

You can't get rid of "Bill Maintenance"; you must keep him on your payroll. It's up to you whether he does guard your profits — or allows them to dwindle month by month.

Help YOUR "Bill Maintenance" close the door to LOSS



INCREASING upkeep costs — dwindling profits! These are the forerunners of serious loss — Just as surely as the carelessly left open door leaves the way clear for thieving night marauders, so do inferior lubricants — or lubricants improperly applied—rob a plant of its most vital asset, *the efficiency of its mechanical equipment.*

IS YOUR "Bill Maintenance" EFFICIENT — *letting nothing impair your plant's earning power? OR is he, unknown to you NOW, letting LOSS creep in?*

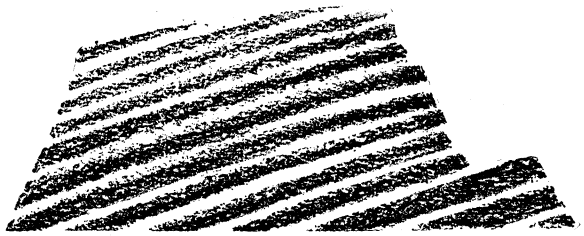
Keystone Lubricants are backed by as wide a lubricating knowledge as exists today. In industry after industry they have effected savings that ordinary lubricants—and ordinary lubricating methods — do not and cannot hope to match.

Honest body and unchanging density have enabled Keystone Lubricants to "lick" the toughest lubricating problems — while everyday routine tasks are accomplished at minimum annual cost—Let a Keystone Engineer help you iron out today's production problems for tomorrow's profits. A visit from him places you under no obligation. Keystone Lubricating Company, 21st, Clearfield & Lippincott Streets, Philadelphia, Pa. Est. 1884.

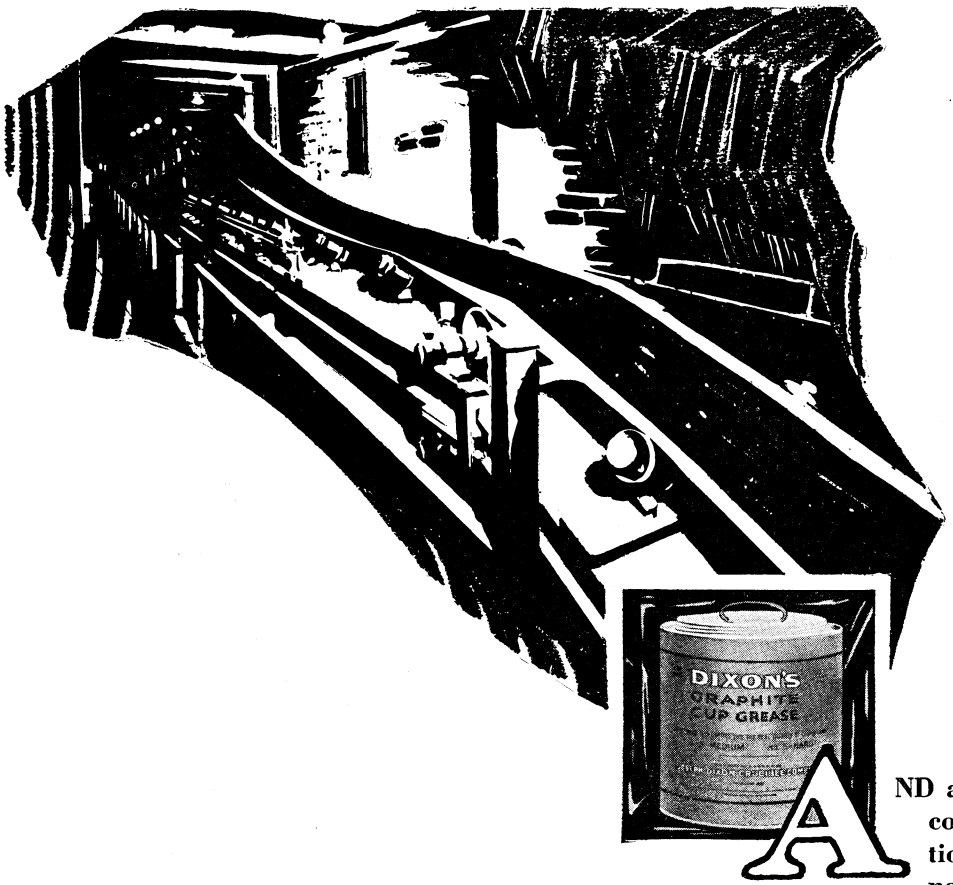
KEYSTONE *Lubricants*

KEYSTONE TRADE MARK REG. U.S. PAT. OFF. GREASE

© K. L. Co., 1931



. . . PUTS A GRAPHITE POLISH ON ANY BEARING SURFACE



AND a polished bearing means cool, easy running. Friction is practically eliminated.

Grease alone can't do this, for graphite has inherent qualities not found in grease. That is why the combination of grease and flake graphite makes an ideal lubricant—as nearly perfect for all classes of lubrication as experience and materials can make it.

Flake Graphite, used in DIXON'S Graphite Cup Grease is not only a lubricant in itself but gives a high polish to bearing surfaces which resists wear.

It readily reaches bearings without the need of heat—and it keeps bearings cool. It is unaffected by heat, cold, moisture, or pressure. This means better lubrication and greater economy in use.

Send for a trial can of DIXON'S Graphite Cup Grease. It is made in six degrees of hardness. Nos. 3 and 5 are in most general use. Write for Circular 96-R.

Other DIXON Products

- Pipe Joint Compound
- Waterproof Graphite Grease
- Industrial Silica-Graphite Paint
- Flake Graphite
- Solid Belt Dressing

Joseph Dixon Crucible Co.

Jersey City D X N TRADE MARK New Jersey

Established 1827

DIXON'S GRAPHITE CUP GREASE

Anderson "Man-Size" Steam Traps

This is the steam trap that engineers swear by, not at. Make your next trap an Anderson.

Send for Catalog.

THE V. D. ANDERSON CO.
1949 W. 96th Street, Cleveland, O.

Branch Sales Offices: 100 Pearl St., Boston, Mass.; 242 Race St., Philadelphia, Pa.; 1932 Calvert Ave., Detroit, Mich.; 11 W. Redwood St., Baltimore, Md.; 565 Washington Blvd., Chicago, Ill.

SAVE *Fuel and Costly Repairs* with McDANIEL Intermittent Steam Trap

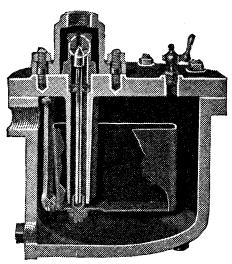
Send for Complete Catalogue

Here is the trap that CANNOT blow steam when discharging!

Discharges ONLY when the open float is filled. Closes positively with a complete water seal over the discharge valve.

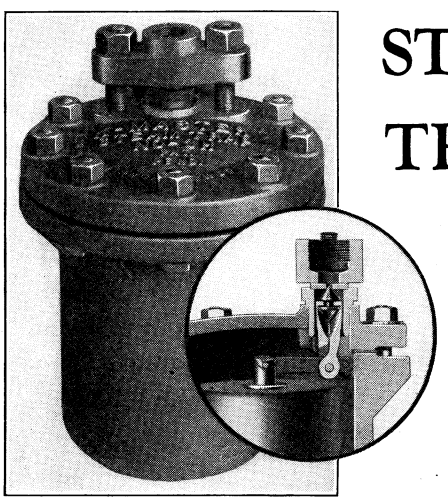
Baffling of the outlet tube PREVENTS swirls of condensate. Reduced velocity of discharge lengthens life of valve seat and stem.

Write for full information —including other features of this outstanding trap.



Watson & McDaniel Co.
Manufacturers of Steam Saving Devices
448 N. Marshall St.
PHILADELPHIA, PA.

K-MASTER
TRADE MARK



STEAM TRAPS

The Modernized Inverted Bucket Steam Trap

No Concealed Steam Leaks!!

KAYE & MacDONALD, Inc. (Formerly K. & M. Steam Engineering Co.)
Representatives in Principal Cities
96 Franklin Ave., West Orange, N. J.

SARCO Self-Adjusting STEAM TRAP

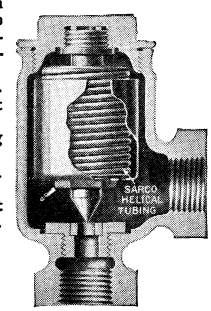
Simply screw the Sarco Steam Trap No. 9 into your pipe-line and it is ready for business at pressures from 0 to 100 lbs. It is self-adjusting—nothing to adjust. That saves time. Saves work. Eliminates possibility of wrong adjustment by inexperienced help.

It drains all condensation as soon as formed. Doesn't leak—doesn't waste steam. Cannot air bind.

Is simple in operation. Has only one moving part—nothing to get out of order.

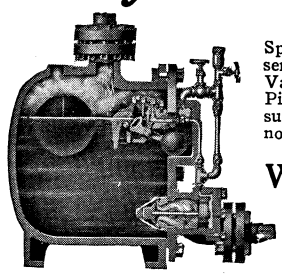
Needs no floor space or building up, and can be placed anywhere on the line.

It costs about one-third the price of bucket or float traps. Sold on 30 days' free trial. Booklet B-95 on request.



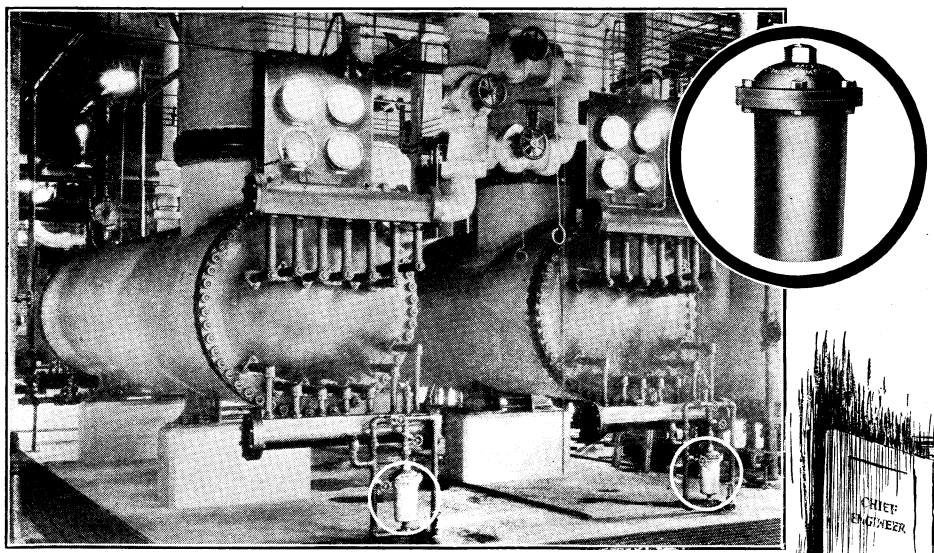
SARCO CO., Inc.
183 Madison Avenue, New York City
Branches in Principal Cities

NICHOLSON Super Traps— *from a complete line of money-saving specialties*



Write for the details about Nicholson Specialties that include Traps for all services and Three and Four-Way Valves. Shown here is the Nicholson Piston-Operated Super Trap for pressures up to 1350 lb. Large capacity—no steam loss.

W. H. Nicholson & Co.
120 Oregon St.
Wilkes-Barre, Penna.



Armstrong traps in refinery of Sinclair Refining Co. at Wellsville, N. Y.

WHEN companies with big engineering departments buy Armstrong traps—

WHEN big industrial concerns, with engineering facilities for testing all makes of separating traps, use hundreds of Armstrong Inverted Bucket Traps, it is obvious that they give outstanding satisfaction. In fact, there are more Armstrongs in use than any other mechanically operated trap; some companies have over a thousand each, and a large number have over a hundred each.

Armstrong Traps have attained their leadership, not through one or two features, but because they have *all* the characteristics necessary to efficient and attentionless trapping.

Their record in all steam-using industries has been such that we do not hesitate to send as many as desired for 90 days' free trial.

At the end of the trial period the traps are to be returned collect. You find out for yourself, under your own conditions, that Armstrongs cannot airbind; do not clog on scum, oil or sediment; are small in size with large capacity; are always water sealed against steam or gas leakage; have chrome steel valves that do not wire-draw and score . . . in short, that they give practically attentionless service. Made in sizes and types for use with steam at any commercial pressure and superheat; and for gasoline service at 1500 lbs. pressure and over. Furnished with special buckets for gasoline service.

Write us giving pipe sizes, pressures, equipment to be used on, kind of service, etc., so we can send the right traps for your free trial.

ARMSTRONG MACHINE WORKS

810 MAPLE STREET :: THREE RIVERS, MICHIGAN

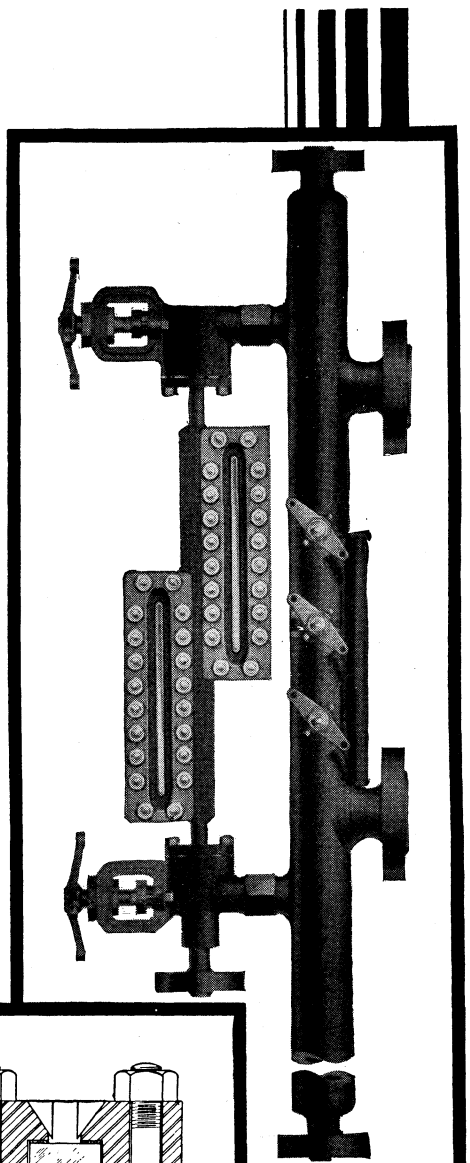
District Representatives in 42 Cities

PPE-3-1-Gray

"LOOSE WINDOW" CONSTRUCTION

GLASS FREE FROM
CLAMPING STRESSES ≈ LONGER
WINDOWS ≈ EASIER READINGS

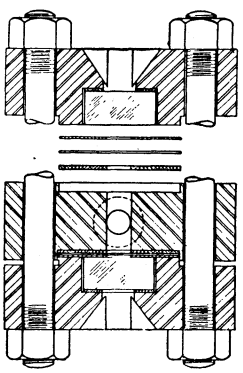
DIAMOND
HIGH PRESSURE GAUGE GLASS AND WATER COLUMN



Highest pressures . . . expansion and contraction strains . . . have no destructive effect on this gauge glass.

With this *patented* and *exclusive* construction the glass is never subjected to a greater strain than the steam pressure.

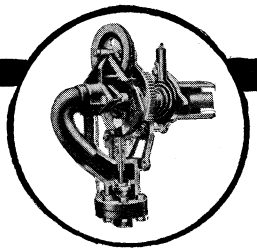
Diamond construction eliminates clamping strains and permits movement of the "loose-window" to compensate for the difference in co-efficient of expansion between glass and steel.



Trouble-free construction throughout. Valve bodies of forged steel. Renewable stainless steel seats, and Monel self-aligning discs. Monel valve stems.

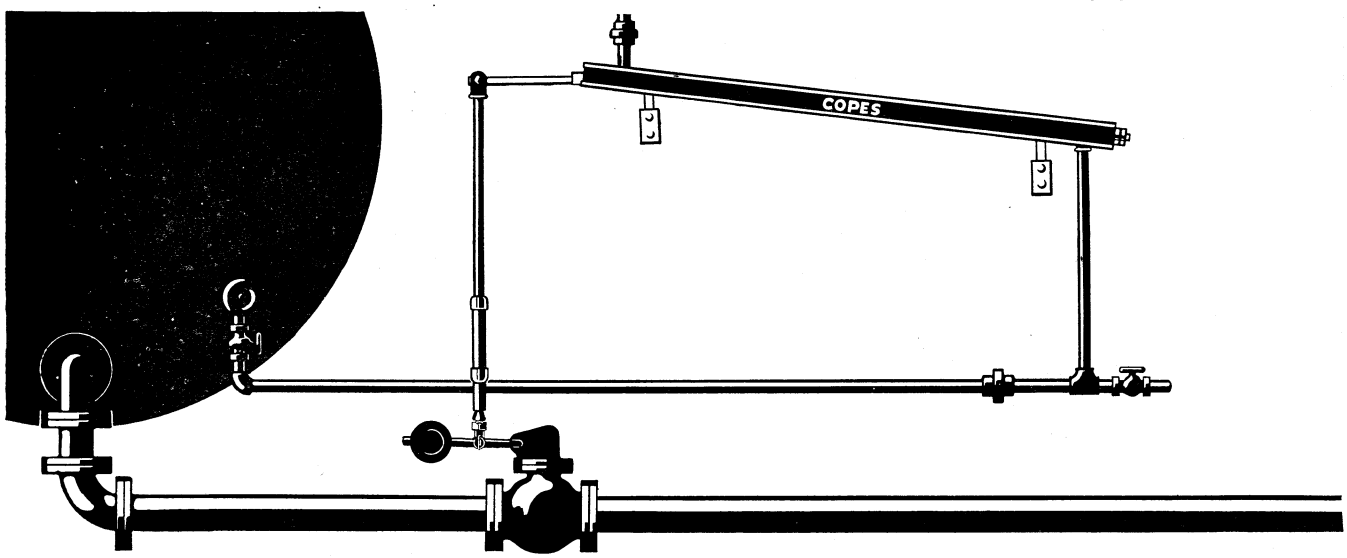
Makers and users of high-pressure boilers are eliminating forever the inconvenience, and expense of ordinary gauge glasses by specifying—

DIAMOND
HIGH PRESSURE GAUGE GLASSES AND WATER COLUMNS



MADE BY THE MAKERS OF
DIAMOND SOOT BLOWERS

DIAMOND POWER SPECIALTY CORPORATION
DETROIT, MICHIGAN



WHY THROW AWAY FUEL?

You can operate boilers with ordinary feed water regulation. But why do it? Users report fuel savings from 1½ to 5 percent with scientific COPES Regulation. Can you afford to throw away this much fuel?

The cost of a COPES installation is so small that the equipment pays for itself several times each year it is in service. And performance records of 10 years or more are common for COPES. The only boiler room which does not benefit from COPES Regulation is one which does not use it.

The 1931 COPES . . . with improved designs and specifications . . . offers the greatest regulator value in history. Write now for facts.

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on the

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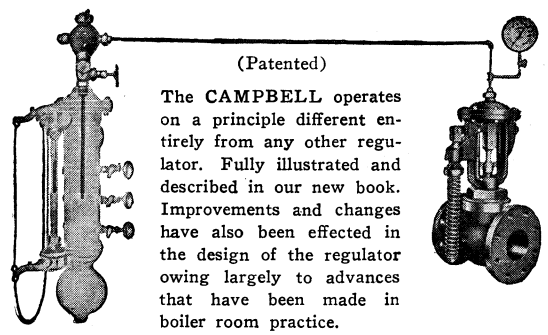

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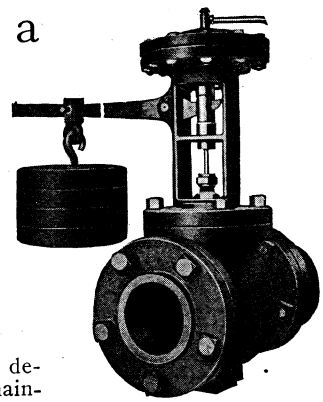

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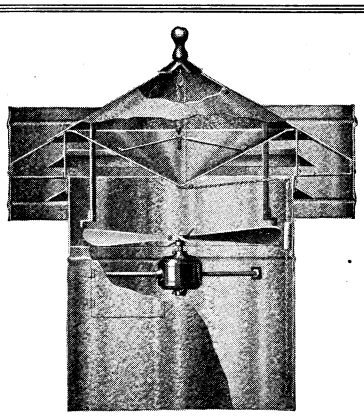

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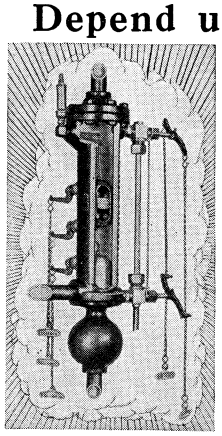

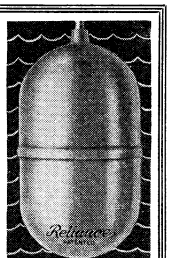

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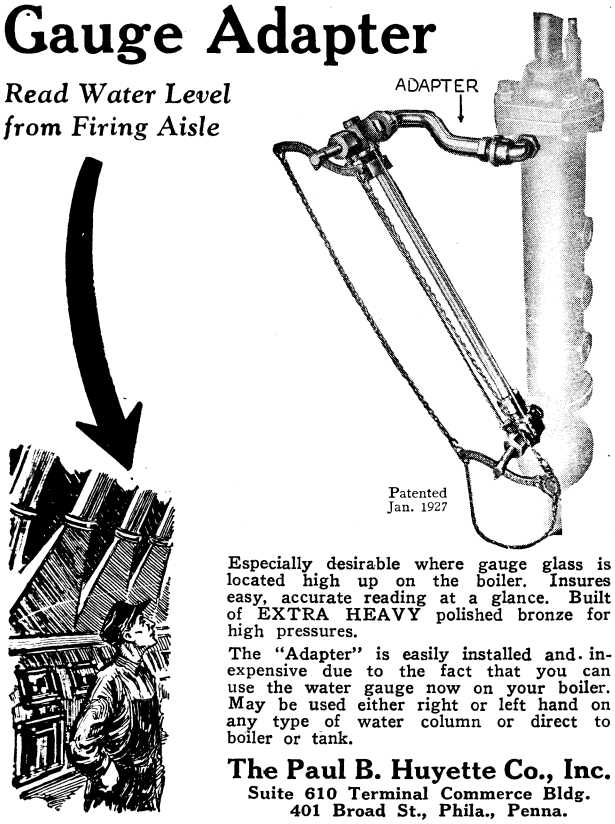

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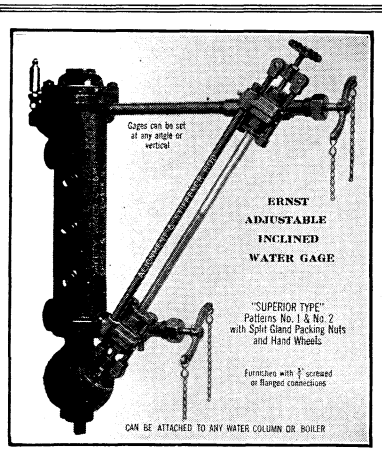

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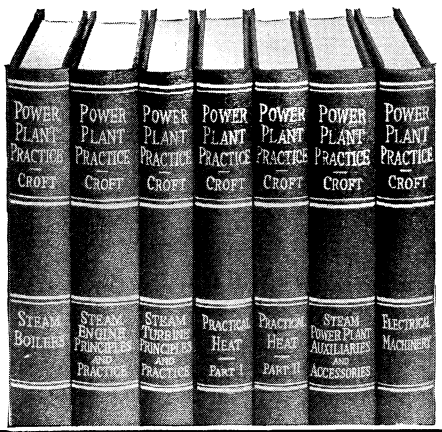

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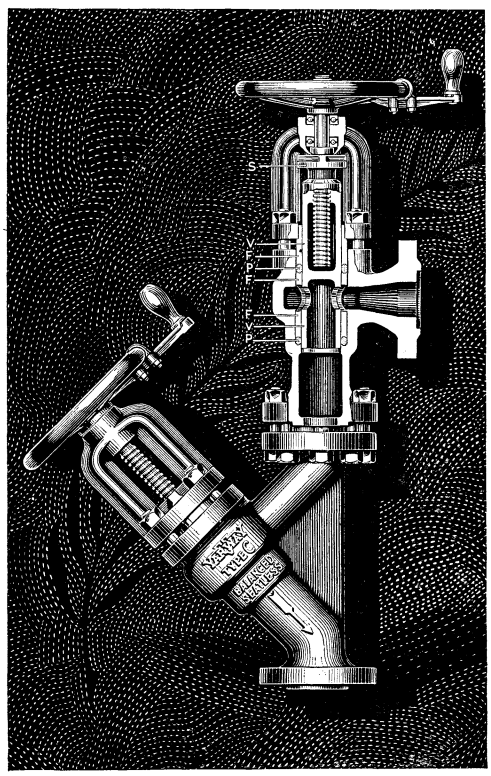

Operation: After valve is closed, shoulder S on plunger V contacts with upper follower gland F, forcing it down into body and compressing packing P above and below port.

Threading inland waterways and bridging the seven seas, steamships carry nearly 5 billion dollars worth of American goods annually to every port in the world * * In many seafaring power plants, as in ten thousand installations ashore—Yarway Blow-Off Valves have been the choice for dependable, trouble-free service and long life * * Among the steamship operators and builders who have purchased Yarway equipment are the American Shipbuilding Corp., Bethlehem Shipbuilding Corp., Great Lakes Transit Corp., Luckenbach Steamship Company, C. D. Mallory & Company, Munson Steamship Lines, Newport News Shipbuilding and Dry Dock Company, New York Shipbuilding Company * * Yarway Blow-Off Valves are made in marine bronze, grey iron, electric furnace and forged steel, singly and in tandem for pressures up to 2,000 lbs. Send for Catalog B-417, describing all types * * Yarnall-Waring Company, Mermaid Street, Philadelphia

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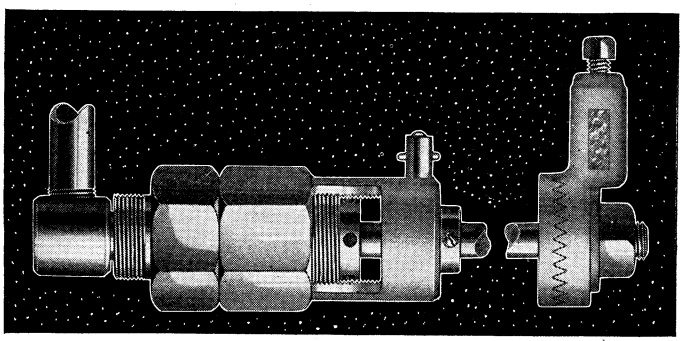

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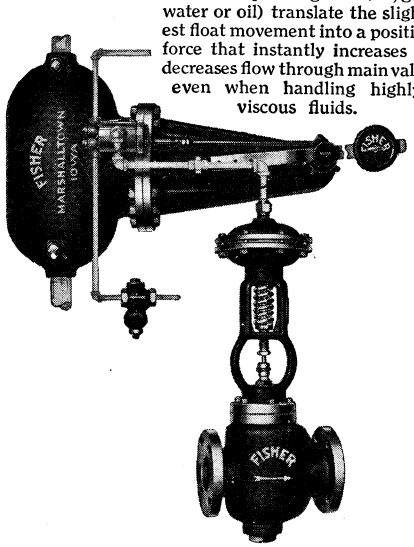

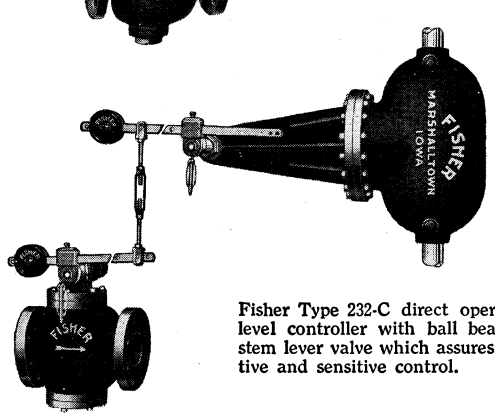

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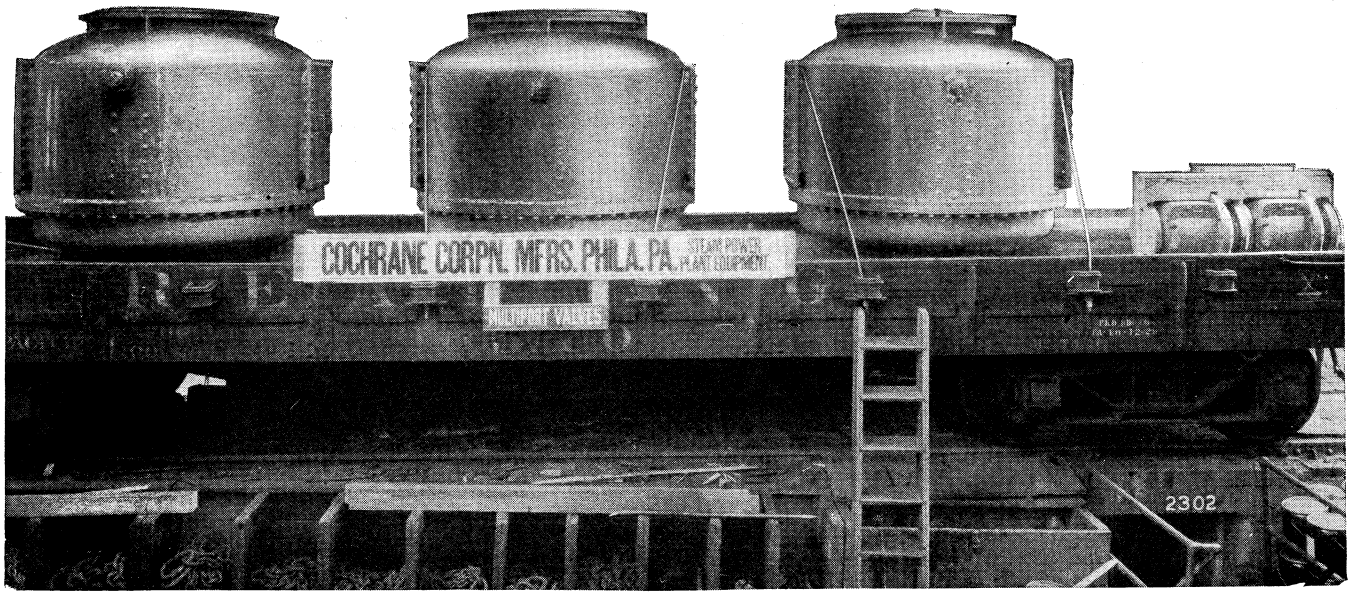
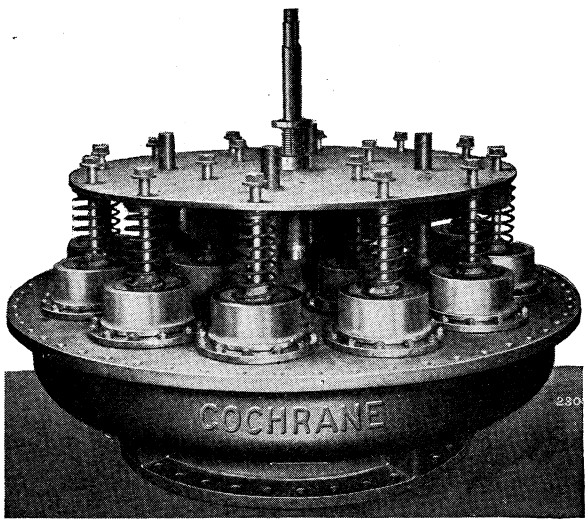


A Carload Shipment of 42-Inch COCHRANE MULTIPORTS



THE Cochrane Multiport Exhaust Relief Valve construction is ideally adapted for large capacities, since the small individual valve disks do not distort and become leaky from expansion by heat and do not set up large inertia forces. Each disk is cushioned by an independent vapor chamber and hammering or rattling cannot occur. Each disk is held to seat by a spring and the tension upon all of the springs can be regulated simultaneously within predetermined limits by a pressure plate adjusted by means of a hand wheel or sprocket on the outside of the casing, or the disks can all be lifted clear of the seats for free exhaust. There is no part directly connected to the disks extending through the casing, hence no possibility of jamming or obstruction by external objects, or of tying down.

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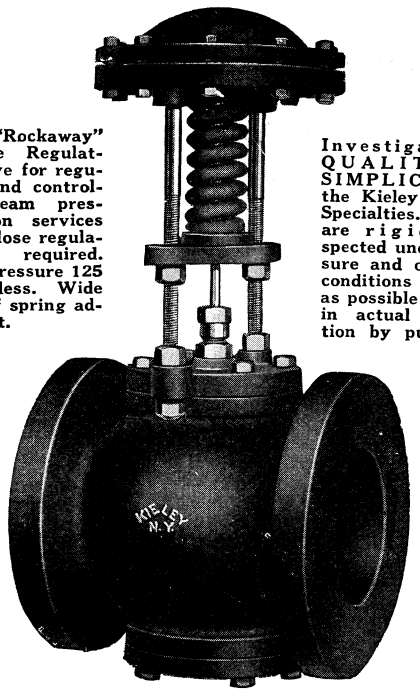

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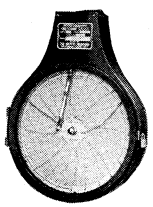

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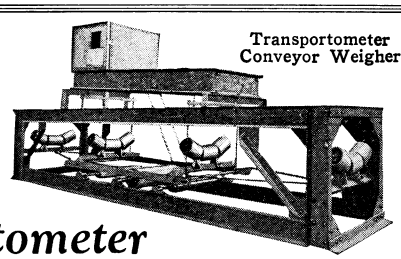
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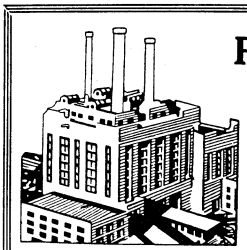

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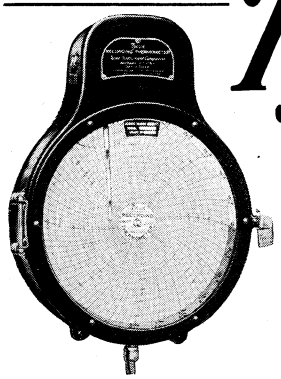

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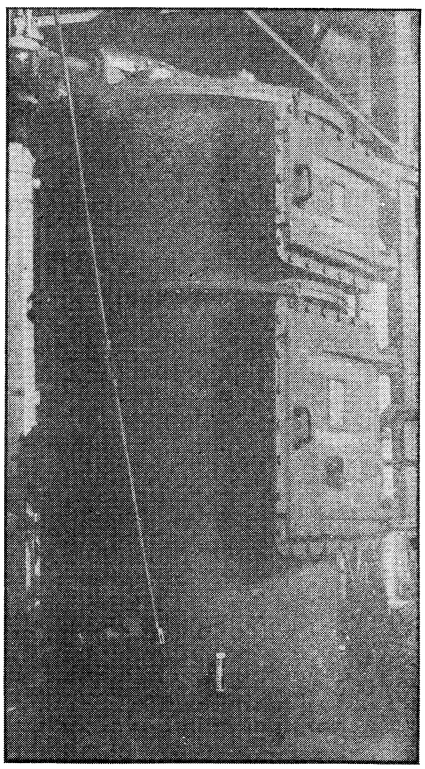

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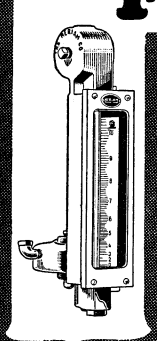

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ANY—Pressure
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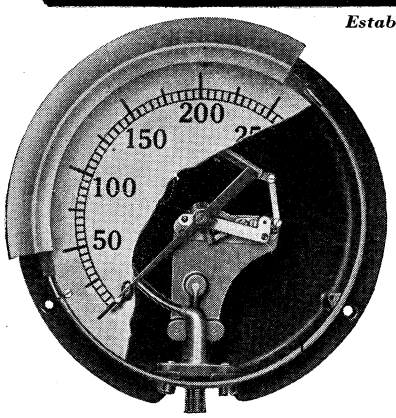

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Check this Pressure Gauge point by point and note how carefully it has been designed and manufactured to secure the utmost in accuracy and dependability.

Note the suspended movement, supported free from the back of the case by the cast bronze gauge socket, with machine-fitted thrust joint between case and socket. Observe the easy-reading dial and pointer . . . the simple mechanism with its strongly proportioned parts. The case is dust-proof and moisture-proof; pinion, arbor, hairspring and bushing are of phosphor-bronze.

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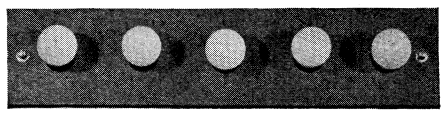
THE NEW L&N SMOKE RECORDER

Operates On A New Principle

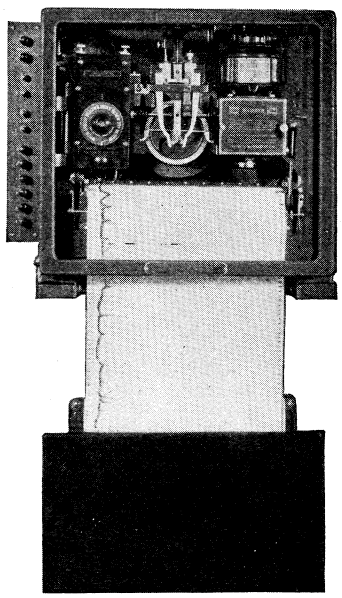


AN L&N Smoke Recording Equipment consists of a measuring chamber installed at the stack or breeching, a recorder at any convenient location and an indicator at the boiler.

The measuring chamber, through which the smoke passes, contains a lamp (at one end) and a specially constructed temperature compensated thermopile (at the other). Energy radiated from the lamp passes through the smoke-filled chamber and falls on the thermopile. There is a constant energy-source in the lamp, and therefore the amount of energy falling on the thermopile is inversely proportional to the density of the smoke. The energy from the lamp which reaches the thermopile causes it to generate a voltage. The measurement of this voltage is the measure of the smoke density.

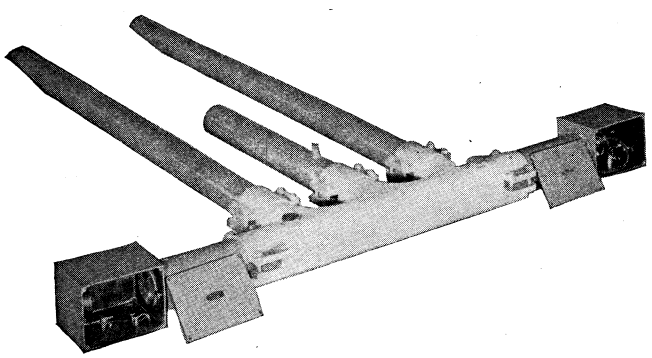
The recorder is a standard L & N Potentiometer Recorder. It measures the voltage of the thermopile and reads directly in either percent smoke density or Ringelmann chart numbers.

The boiler-room indicator is a bank of five lamps. The color of the lamp burning instantly tells the fireman the smoke condition in the stack.



Above is shown the boiler-room indicator, the smoke recorder and the control box. These parts of the equipment may be placed at any convenient locations.

ADVANTAGES OF THE L & N SMOKE RECORDER



The measuring chamber with the sampling pipes attached is shown above. The thermopile is in the box at the left and the lamp in the one at the right. The three pipes are the only parts that must be placed in the stack or breeching.

1. The boiler-room indicator instantly tells the fireman the smoke condition.
2. The Recorder furnishes a continuous record 24 hours a day.
3. The apparatus is simple, reliable and fool-proof. A specially constructed thermopile is used as the detecting element.
4. The density measurement is not affected by line voltage fluctuations.
5. The sampling system of which the measuring chamber is a part, is easily installed, requires very infrequent attention, and provides a ready means for obtaining a condition of zero smoke density for purposes of checking.

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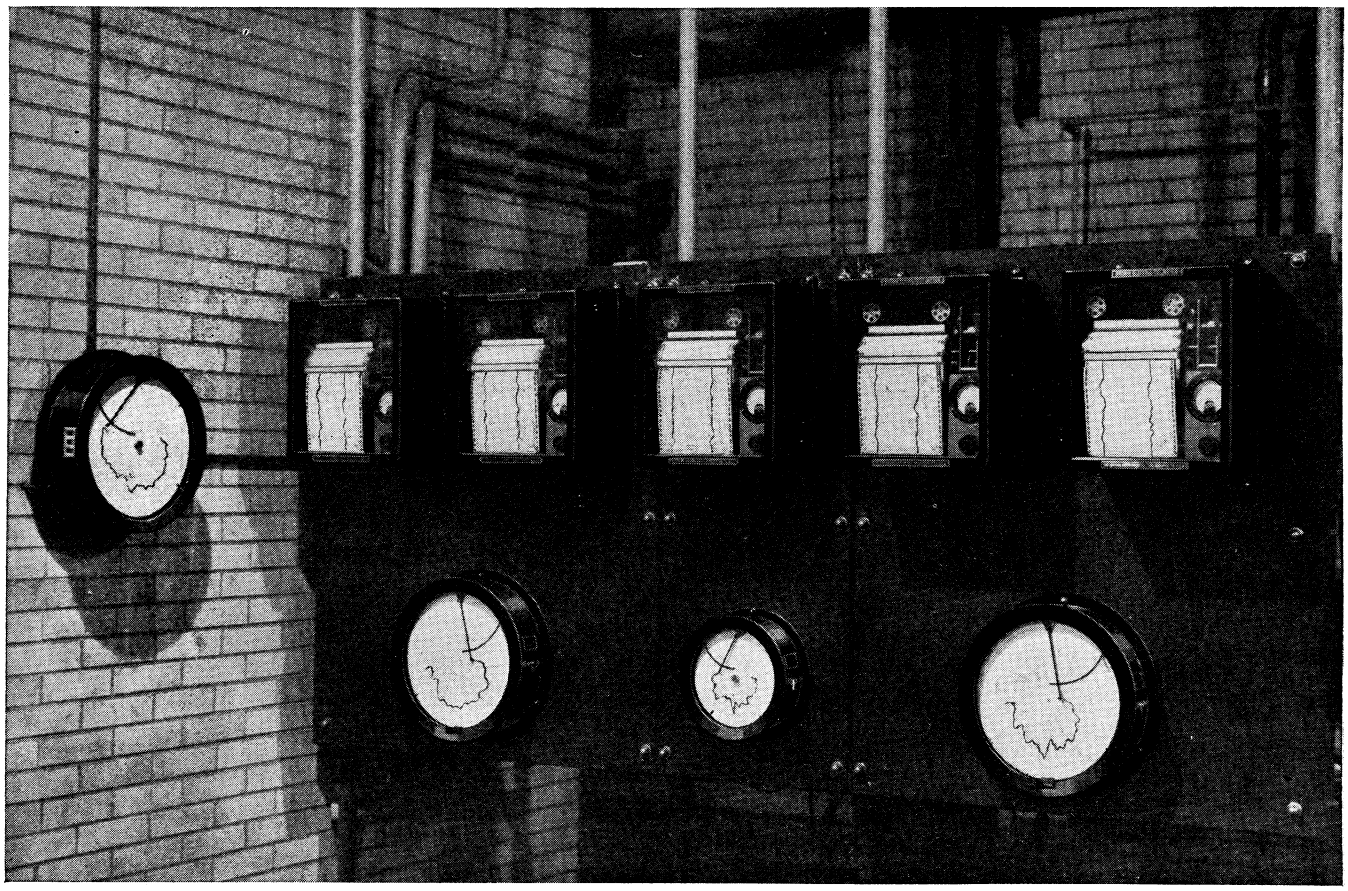
HUMP AND HOMO HEAT TREATING FURNACES
AUTOMATIC COMBUSTION CONTROL
G-244



It Guides the Fireman and Guards the Coal Pile

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That's flexibility, efficiency and convenience, as well as speed. All features you need to get the most out of CO_2 metering. Write for full details of the new Brown Electric CO_2 Meter, and for Catalog 34.

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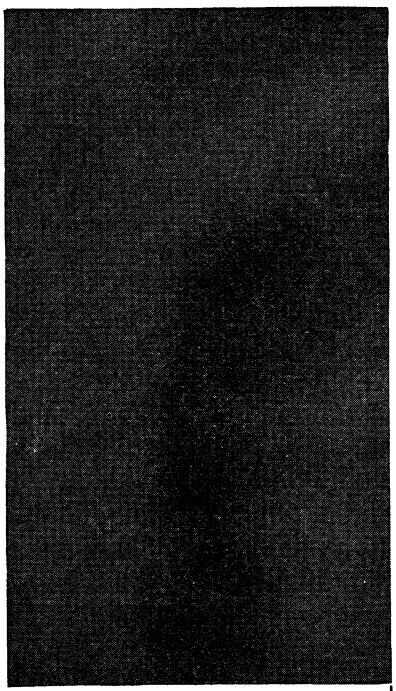
to measure is to economize



EQUIPMENT ESSENTIALS

DESIGN WORKMANSHIP MATERIAL

Vol. II No. 3

Proper materials essential to insure hair-line accuracy of fluid meters

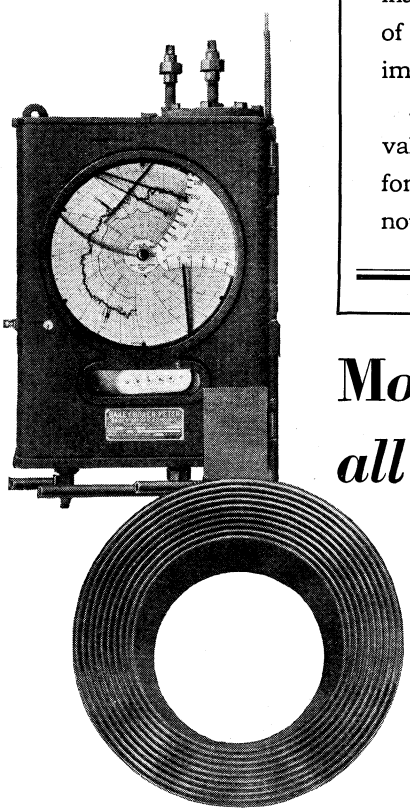
By H. M. HAMMOND, *Manager, Sales and Engineering*
The Bailey Meter Co., Cleveland, Ohio

To meet the requirements of the modern central station or industrial power plant, metering equipment must be extremely accurate and dependable. Since the accuracy of a fluid meter originates at the orifice, the design of this element is of considerable importance.

An orifice would be of little value even though accurate before going into service, if it were not constructed of the proper material. This material must be tough and must resist corrosion by liquids and gases at high temperatures and pressures. It must be able to withstand the cutting action of steam or water flowing at high velocities. Finally it must be rigid so that the orifice will retain its original shape.

Only by use of a material meeting these requirements can hair-line accuracy of an orifice be retained indefinitely.

This is one of a series of editorials in which leading figures of the power industry stress the importance of Material —the 3rd Essential—in modern power plant equipment.



Type D-26, Class 56 Bailey Boiler Steam Meter for indicating and recording flow of steam from boiler, air to furnace, furnace draft, and temperature of flue gas, with 6" eccentric type of Monel Metal orifice plate for high pressure steam meter, as manufactured by THE BAILEY METER CO., Cleveland, Ohio.

Monel Metal . . . the 3rd Essential in all BAILEY *steam and water orifices*

Because orifices play such a vital part in insuring the accuracy of precision metering instruments, The Bailey Meter Company has devoted years of research to orifice materials. Their choice of Monel Metal as the standard material for all Bailey meter orifices is the logical result of this study in which Monel Metal proved to possess the best available combination of essential properties. Monel Metal's rust-immunity, corrosion- and erosion-resistance, and great rigidity go far to assure that enduring accuracy which has made Bailey Meters big sellers in the power field.

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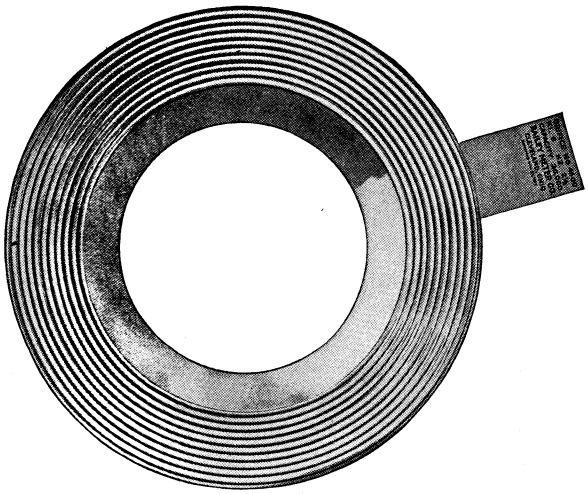
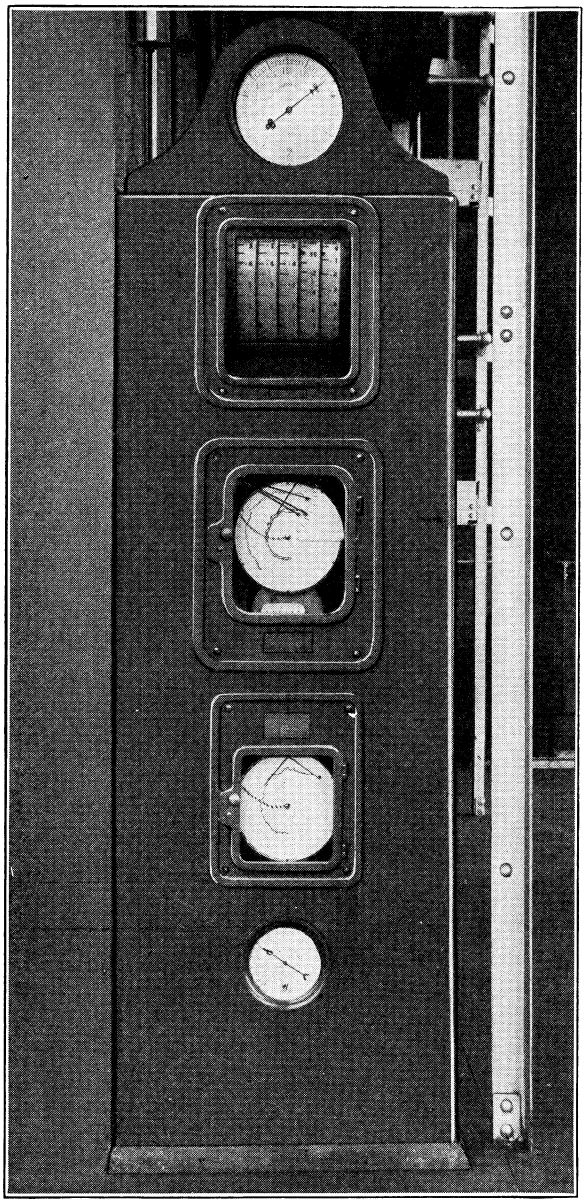


THE OUTPOST OF ACCURACY



THROUGHOUT THE COUNTRY thousands of Bailey Meters operate day after day, year after year, with unfailing accuracy. Each meter has as an outpost in its pipe line a Bailey Orifice or Flow Nozzle which quickly senses the ever changing flow conditions, and accurately transmits them to the flow recording mechanism of the meter.

● Hidden away between the flanges of a pipe line, the orifice plays a vital part in the operation of the meter to which it is connected. It is an outpost of accuracy.

● Years of careful research have been spent by the Bailey Meter Company to determine the correct coefficients and characteristics of various types of orifices. The result of this extensive study goes into the design of each Bailey Orifice. A rigid inspection in the factory before shipment and a careful examination of the actual installation by a Bailey Engineer, makes sure that the benefits of this research show in every Bailey Meter installation.

● Under severe operating conditions, hair-line accuracy is retained for years because of the material from which these orifices are made. Wear and corrosion have been overcome by the use of Monel Metal as a standard material for all Bailey steam and water orifices.

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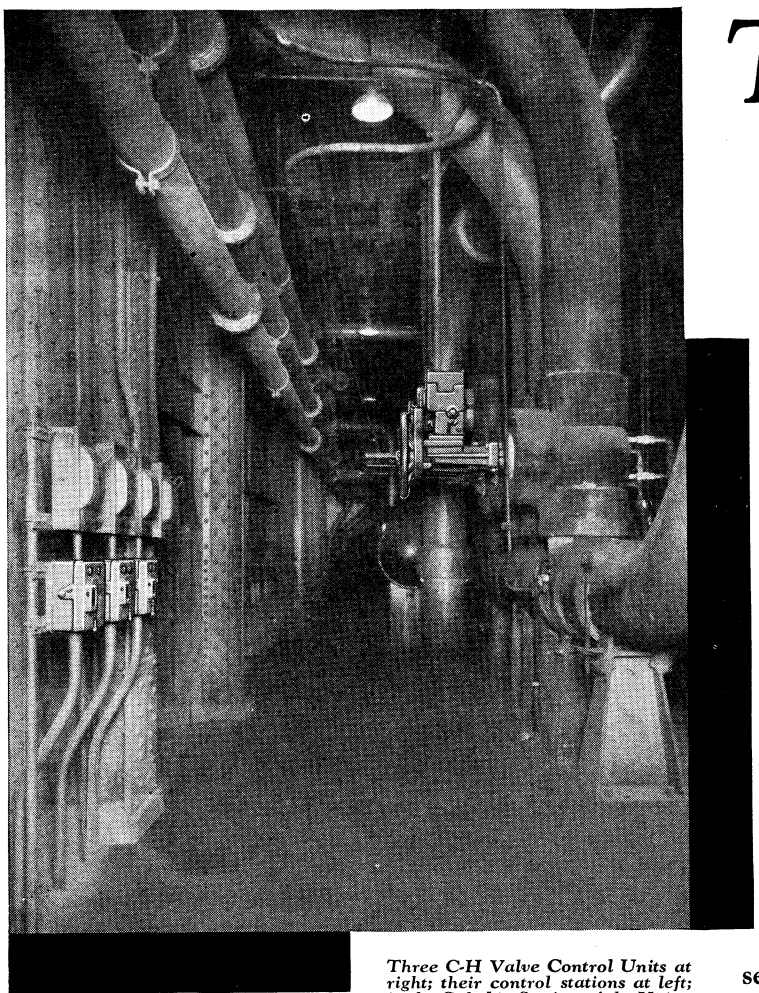

Three C-H Valve Control Units at right; their control stations at left; in the Cahokia Station of the Union Electric Light & Power Co., St. Louis, Missouri.

Then how are your valves operated?

NO plant receives the full economy of modern steam-plant practice...if important valves are still operated by hand. Motorizing them, applying Cutler-Hammer Valve-Control Units, saves time, labor and steps, provides positive life-and-property insurance in emergency. C-H Valve-Operating Units place control of the entire system at a central station entirely in the hands of one man. They permit individual operation of each valve as well, from a locally and conveniently situated push-button. They handle—speedily and without fault—any changeover from the simplest to the most intricate sequence.

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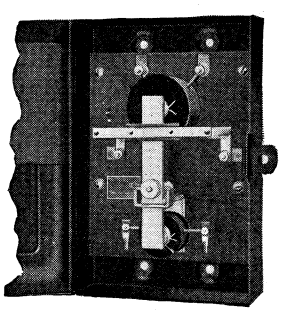
Pound-foot for pound-foot of delivered energy—the *only* standard by which to judge—C-H Valve Units cost no more than less effective systems. This modern steam-plant economy is completely described in the booklet "*Modern Valve Control Practice*". A copy will be sent upon request.



C-H Valve Tight-Seating Relay

Operates on lockout principle. Seating torque is adjusted easily within very close limits. Once the seating relay is adjusted, the valve is always seated with the same degree of tightness regardless of varying conditions.

C-H VALVE CONTROL NOW SUPPLIED FOR ALL VALVES FROM ¾" UP

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C-H Valve Control System

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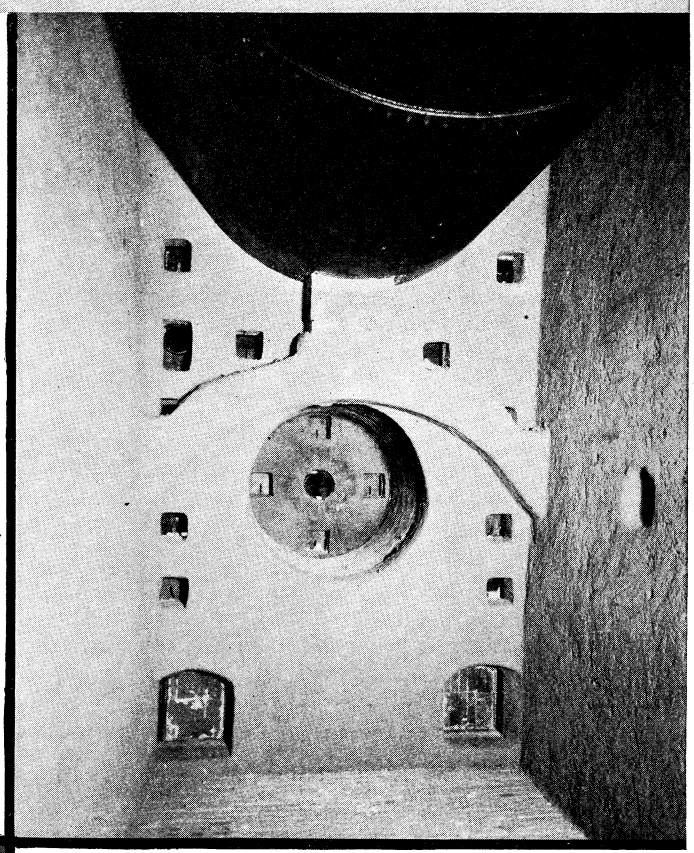

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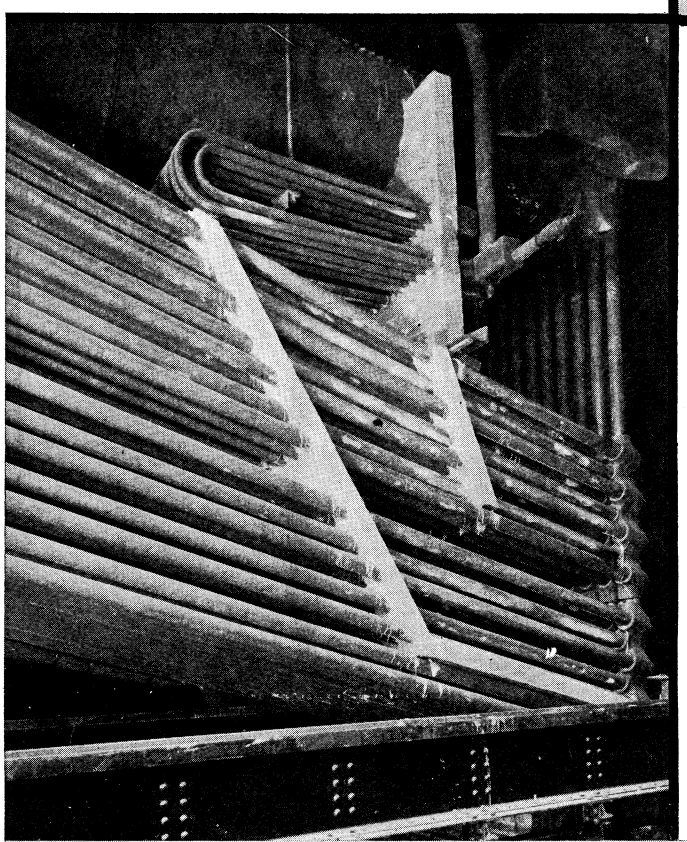

Opposite. Beco-Turner baffle in 500 hp. B. & W. boiler at Jos. Schlitz Beverage Co., Milwaukee. One of three installations.

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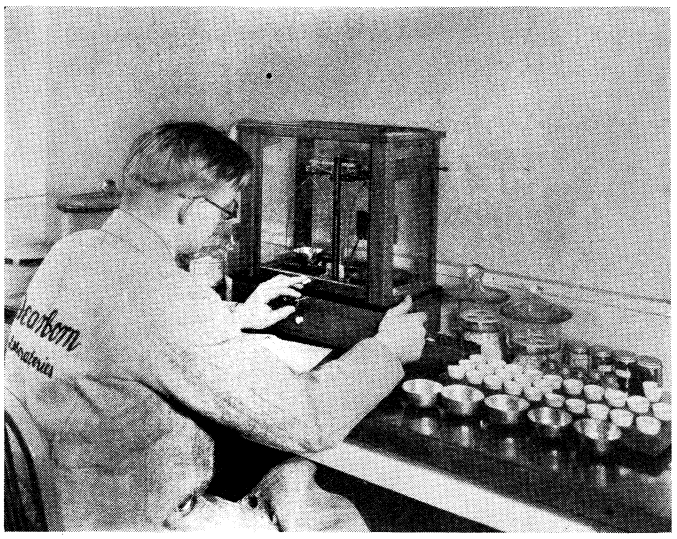

The Challenge of Increasing Pressures

Increasing pressures demand exact scientific accuracy in correction of harmful water tendencies.

Both high efficiency and safety are dependent upon complete correction of conditions that may cause scale formation, foaming, embrittlement, pitting and corrosion. The challenge of modern pressures is not as simple in regard to correction of water troubles as might appear. New considerations arise. Some corrective agents which produced desirable results under low pressures decompose chemically at higher pressures and produce the causticity which makes embrittlement possible.

Changes in boiler design, increased speed of circulation, reduction of relative volumes of water and increased evaporation per unit of heating surface have required that each feature be met with suitable types of treating materials.

The Dearborn Chemical Company is working actively and successfully with these problems today, but the story of our accuracy and ability in water correction at modern pressures is the story of exacting research over nearly a half century. Ready ability to assume responsibilities and to overcome difficulties in their field of work, has been this company's contribution to progress.

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Our service, our responsibility for results and the high effectiveness of our work are available to you, regardless of operating pressures and location. Write us describing your conditions. Send a gallon sample of your water supply to our laboratories at 1035 W. 35th Street, Chicago.

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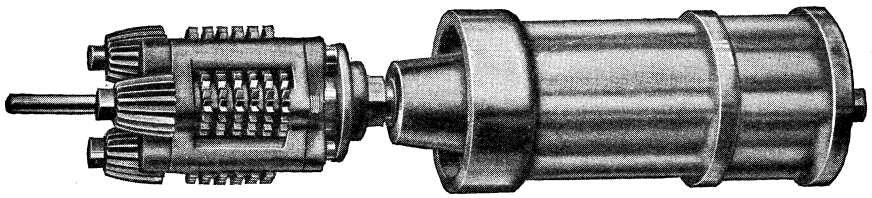

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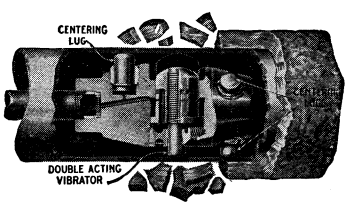

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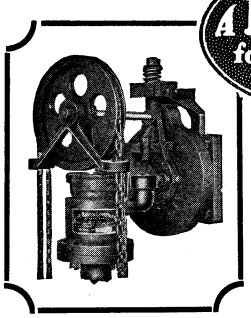

A BAYER for every type of boiler

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Let the Mohawk Chief increase economy in your plant by ridding your boilers of scale.

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"The fuel saving alone amounted to more than 20%"

30 years of "Know How"

"Bare metal was all that confronted us," adds the superintendent of city water works, after using the Hawk-Eye Compound that we had provided for badly scaled-up boilers. It costs you nothing to find out what Hawk-Eye will do in your plant. Write.

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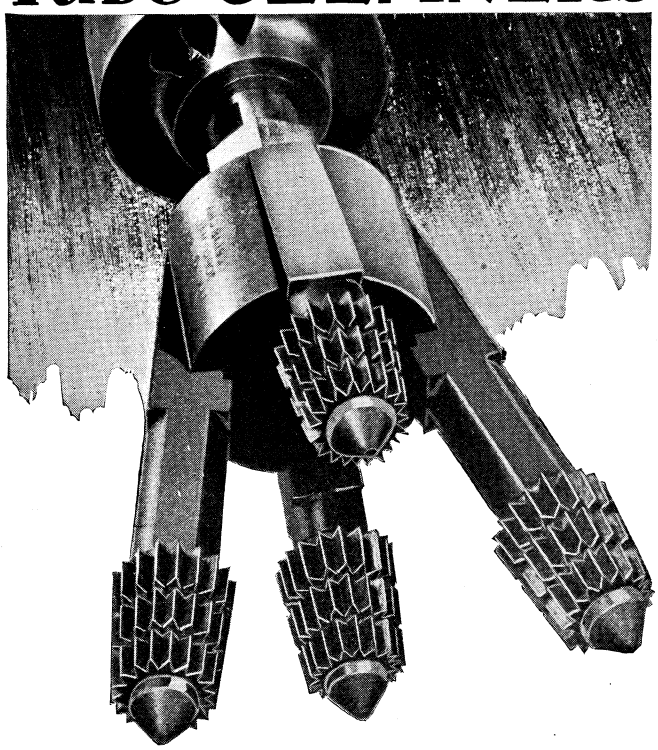

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Comparatively, it is as easy as putting a new blade in your razor, to put new cutters in this Liberty "No-Rivet" Cutting Head, when long service has required it.

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Liberty Cleaners are made for all types of drive —air, steam or water, and in sizes for cleaning any tube or pipe from 1¼ in. I. D. to 10 in. They are remarkably powerful, sturdy, enduring and effective. They can be supplied with various types of cutting heads to meet specific needs.

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VOL. XXXV CHICAGO, MARCH 1, 1931 No. 5

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Page

Steam for the New Empire Refinery 288
Increasing Plant Efficiency by Condenser Maintenance ... 293
Trends in Steam Turbine Development. By A. G. Christie 295
Pulverization and Boiler Performance. By E. H. Tenney 298
Check on Combustion Conditions in Engines. By Robertson Matthews 300
Electricity—What It Is and How It Acts. By A. W. Kramer 301
Program of Varied Interest at A. I. E. E. Meeting 304
High Temperature Metals for the Power Plant. By H. W. Spring 307
Modern Ice Plant in Kansas City 309
Power Saved in Industrial Plant by Remodeling for Motor Drive and Centralized Control of Operation. By L. A. Corwin 310
Compressed Air in the Industrial Plant 312
Protective Grounding of Electrical Systems By O. H. Henschel 313
Rio Grande Station Burns Natural Gas 314
Power Engineer Must Be a Diplomat 315
Letters Direct from the Plant: Attachment of Relief Valve Removes Danger of Bursting Condensate Tank. Inside Calking Protects Boilers Against Caustic Attack. Leaky Piston Rings and Valve Test. Arctic Circle Power Plants. Improvements Come as Result of Careful Planning. Unique Soldering Copper Handle. Concrete Makes Inexpensive Repair for Brick Reservoir. Time-Lag Prevents Motor from Burning Out 316
Questions and Answers: Steam Turbine Foundations. Cause and Prevention of Pitting. Greensand as a Zeolite Material. Live Steam for Oil Heating Coils May Raise Temperature Too High 319
Power and Fuel Engineers Meet at Chicago 321
New York Edison to Spend $48,000,000 in 1931 325
Editorial Comment: Public Ownership Steps Out. Why Are Welded Boiler Drums So Long in Coming? The Windowless Factory Is Here. Research and the Plant Engineer 326
Power Show Exemplifies Industrial Progress 328
Rotoscope for Measuring Speed 333
Fitz Auxiliary Hydroelectric Generator Unit 334
Type OT Feedwater Regulator 334
Oil Burner Control System 335
Motor Starter 335
New Induction Undervoltage Relay 336
Belt Pull Comparison 336
New Portable Lifts 336
Dual Twist and Hammer Drill 337
"Double Minded" Transformers 337
News Notes 337
Books and Catalogs 338
Power Plant Construction News 340

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Flowers of Industry

FLOWERS, THE POETRY of earth, have always spoken the language of Romance, whether they be an offering from the new boy friend or a belated anniversary remembrance from hubby. Now, after centuries of waiting, they have invaded the realm of Industry which so many altruistic critics have branded as a soulless siren bent on the destruction of mankind.

But times have changed. Today, in steel mills, sparkers run to and fro with their offering of flowers and Industry accepts them with the demureness of a maiden enamored of her first love.

And such flowers as they offer! Sparkling, scintillating bouquets which Science has turned to good advantage in the sorting of alloy steels. When ground on an emery wheel each steel gives a characteristic spark which serves as a means of identification. Sparks from a 1.00 per cent carbon steel, as made at The Timken Steel & Tube Co. plant, where this method of testing was developed, are shown above.

Sparks, then, are a measure of the quality of the steel just as discussion is a measure of the quality of a paper at an engineering meeting. Many of the papers presented at the recent Midwest Power Conference are abstracted in this issue and, although the report of the meeting and ensuing discussion is brief, it is sufficient to show the papers that touched on live subjects and drew the sparks.

Steam *for the new* Empire Refinery

NEW EAST CHICAGO REFINERY PLANT OF THE EMPIRE OIL AND REFINING CO., SERVED BY MODERN STEAM PLANT

IN THAT EXTREMELY intensive industrial area surrounding the southern end of Lake Michigan adjacent to the city of Chicago, where mile upon mile of oil tanks vie with the seemingly endless array of stacks and furnaces of the steel mills for domination of the landscape, the addition of a new group of tanks or a new array of stacks is liable to go unnoticed by the layman passing through this territory. It is a district which in the conventional sense presents little esthetic appeal and the layman's attitude toward it is that of submissive tolerance of a necessary evil and his interest in it at best is one of bewilderment at the meaning of it all. Unless one is inspired with the artistic sense of a Joseph Pennel, the romantic aspects of such a scene are likely to be lost. Yet the romance is there to anyone who will take the trouble to learn how to understand.

Consider merely the question of transporting the crude oil to these great refineries. Imagine if you can, the stupendous feat of pumping oil all the way from the oil fields in Texas and Oklahoma—the thousands of miles of carefully guarded pipe line, silent, motionless, but carrying the energy to drive twenty millions of motor cars. Think of the years of mental and physical effort of thousands of minds that served to make this possible.

Oil itself is a romantic thing. There is a romance about obtaining this rare and valuable product, hidden within the earth's crust for untold ages. The search for it, in out of the way places, in lands untouched by civilization, acts as a lure which cannot be explained alone by the material rewards which its discovery has to offer.

And so, in this article which has to do with merely one incident in the story of oil, it is well to keep this aspect of the oil industry in the background of your mind for it will lend importance to the otherwise routine task of furnishing steam to a refining plant.

For notwithstanding the layman's unobservance, an entirely new refinery was placed in operation in the East Chicago district early last spring, that of the Empire Oil & Refining Co., a subsidiary of the Cities Service Co. This plant is located about two miles south of Lake Michigan and comprises some 377 acres of land.

The power plant for this refining plant, as may be seen from the photographs, is built along strictly modern principles and, while not elaborate in its engineering features, is designed to give reliable and continuous service at a cost which is not inconsistent with other elements of cost which enter into the total cost of production.

At the present time no electric generating equipment is installed, the plant serving only as a steam and pumping plant, but the fact that it may prove advisable to install generating equipment at some future time has been kept in mind and the plant has been designed with this end in view. Although the present boilers are limited to a pressure of 275 lb. per sq. in., space has been reserved for additional units, which may or may not be higher pressure units, and allowance has also been made for the addition of a turbine room. As a matter of interest, a refinery power plant does not necessarily need high-pressure boilers. A mixed pressure turbine could be installed, utilizing both high-pressure steam from the boilers and low-pressure exhaust steam from some of the refining processes.

The general features and layout of the equipment in this plant are shown in the accompanying drawings and photographs. The building is substantially constructed of brick, steel and concrete, is well lighted by large windows on all sides and is attractive in its archi-

tectural design. It is faced with red pressed brick and is served by two 235-ft. concrete stacks.

Oil and Gas Used as Fuel

Since the plant uses oil and gas as fuel, no ash handling equipment is necessary but the building foundation was carried deeper than usual in order to permit the installation of ash handling equipment at some future date. The firing floor is on the ground level.

The present installation includes six 507-hp. Babcock & Wilcox Stirling boilers, set singly in two rows of three on each side of the firing aisle. The firing aisle is wide and sufficient space has been provided overhead so that overhead coke bunkers can be provided such that be deemed necessary at some future time.

These boilers have furnaces with air-cooled walls, the Bigelow-Liptak system being used. With this arrangement the side walls are fitted with two sets of air intakes at a point some distance above the floor. The air entering the lower openings passes downways between the side walls to a duct below the furnace floor which delivers the air to the double walls extended up in front of the furnace. Air is also drawn in at the rear of the boiler and this passes down between the rear walls and then underneath the furnace floor to the front of the boiler where it mixes with the air drawn in at the side walls. This air is delivered to the burners and openings are also provided for admitting this air as secondary combustion air. The air entering the upper row of side wall openings passes upward between the furnace walls and is discharged at the top—this air being used only for cooling the side walls and not for combustion purposes. This makes a simple and effective arrangement.

Each boiler is provided with six combination gas and oil burning units, arranged in two horizontal rows of three each. With these burners, both oil and gas can be burned efficiently, separately or simultaneously. At the present time both fuels are used under normal conditions but quite often oil is burned alone. In this case, the gas burners which are connected to the gas lines through a short length of flexible steel hose, are merely pulled back, away from the oil burner, slightly. This prevents the gas burners from clogging up due to the oil being thrown back on them.

Use of Acid Sludge

Two of the six boilers are now being fitted with burners which are designed to burn acid sludge. In the refining processes certain impurities are removed from the distillates by treating them with sulphuric acid. The action of the sulphuric acid is both a chemical and a physical one and forms insoluble chemical compounds with the impurities and also acts as a solvent for them. After the treatment is complete, the acid sludge is allowed to settle and is drawn off. The greater part of the acid so used is recovered and the residue which still remains is known as acid sludge. This sludge, while not an ideal fuel, still has considerable heat value and with proper burners can be burned economically. As it is purely a waste product, its use under the boilers represents a distinct saving.

At the Empire refinery, a certain amount of this sludge is available, so two of the boilers are being equipped to burn it. It will be stored in a 500 bbl. lead lined tank outside the building.

The fuel oil used is stored in two tanks, each having a capacity of 2500 bbl. All oil used as fuel throughout the refinery (not only that used in the boiler plant) is pumped from the boiler house. Because of this the fuel oil pump which is located on the ground floor, is considerably larger than the usual fuel oil pump found in a boiler plant. It is a type HQ Kinney, Heliquod pump, size 10 by 5, and is driven by a vertical steam engine.

No separate oil heaters are provided at present but these are contemplated in the near future. Heaters for treating the acid sludge are also to be provided. The oil

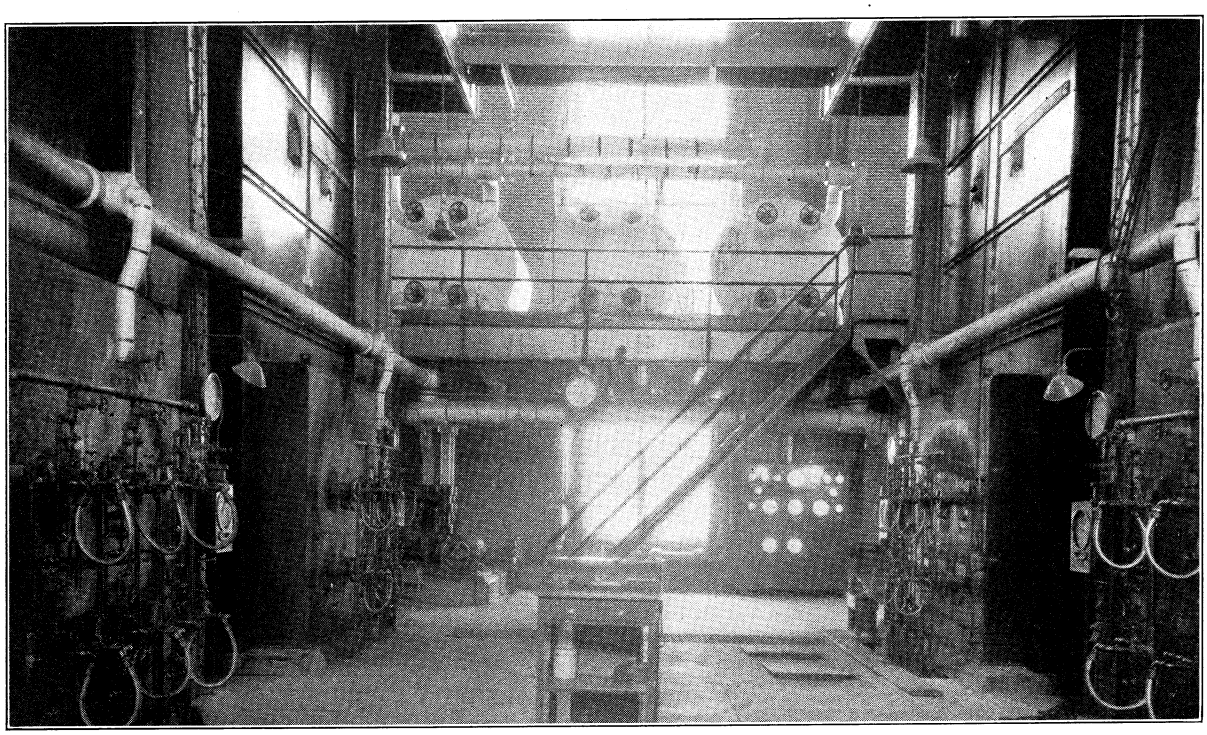


FIG. 1. GENERAL VIEW IN THE BOILER ROOM, SHOWING THE FILTER ON THE BALCONY

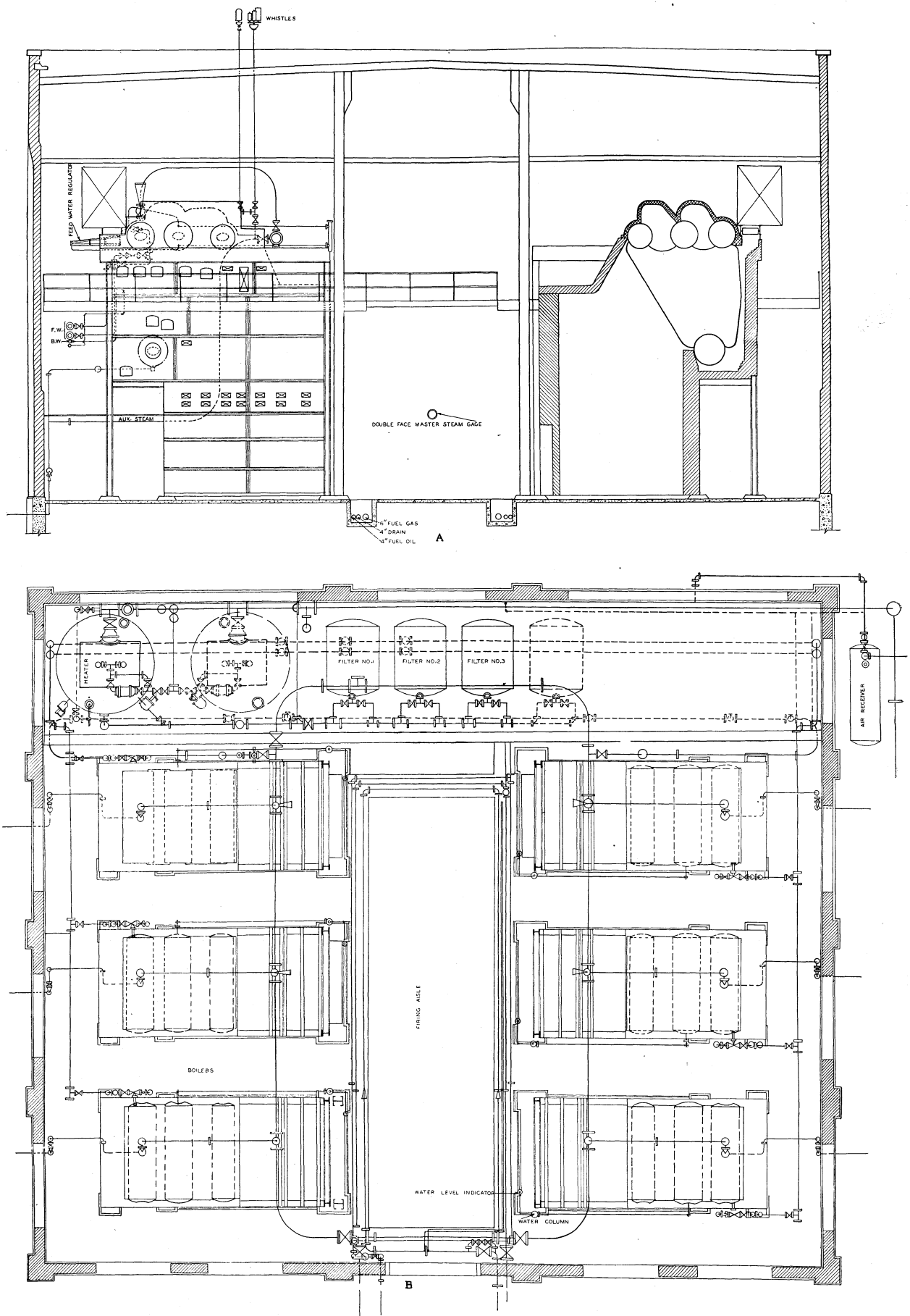


FIG. 2. ELEVATION AND PLAN OF THE PLANT

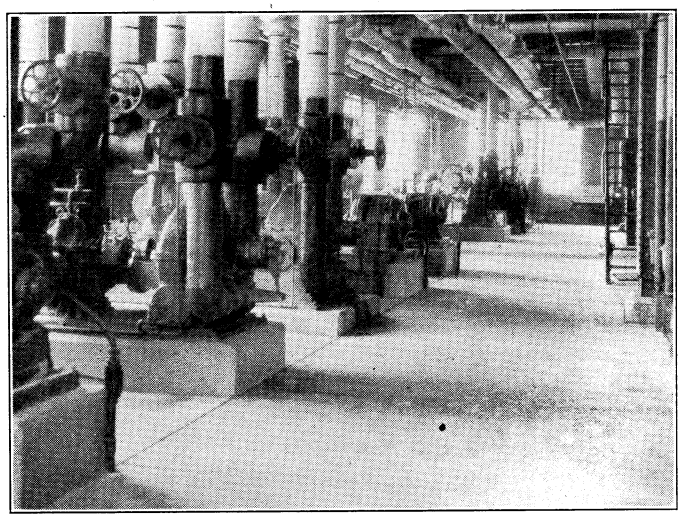


FIG. 3. VIEW IN THE PUMP ROOM SHOWING BOILER FEED PUMPS IN CENTER

burned at present is heated by steam coils in the storage tanks but this does not give a sufficiently high temperature.

Water Supplied from Lake Michigan

Water for use in the boilers is obtained from Lake Michigan about two miles away where a pumping plant is located. This plant is connected to the refinery by a 36-in. main, which is capable of handling all the water used in the refinery. Under normal conditions this is the only water supply used.

For use in case of emergency, however, a 12-in. water line is provided which is connected to the East Chicago city water system. This line is connected with the 36-in. main at the refinery at a point just ahead of a 36-in. electrically operated gate valve. This valve may be closed by remote control and the 12-in. line opened, thus utilizing only the service from the East Chicago system. In addition to this emergency supply there is a separate 4-in. line to the East Chicago system for boiler feed purposes only.

Equipment at the pump house on Lake Michigan consists of 6 Goulds centrifugal pumps of varying sizes five of which are driven by electric motors and the remaining one is driven by a Sterling engine. The latter of course is only for emergency operation in case the electricity supply should fail. Current for the operation of these motors is supplied over two separate power lines at 11,000 v. A transformer station is installed which reduces the potential from 11,000 v. to 2300 v. The three largest pumping units (5330 g.p.m. each) are driven by synchronous motors with direct connected exciters. The two small units use induction motors. The use of the synchronous motors presents an advantage in that a high power factor can be maintained.

A feature of interest in connection with this pump house is that it is located below the Lake level, that is the floor is some 7 or 5 ft. below the normal lake level. Thus there is always a head on the suction side of the pumps.

From this brief description it will be evident that any conceivable emergency condition has been provided for and that an absolute failure of all water supply is only a remote possibility.

Water for boiler feed purposes is treated in an International hot process line, soda ash system. This equipment consisting of three horizontal filter tanks, chemical mixing tank, sedimentation and treating tank and water heater, is located at one end of the boiler house, all equipment with the exception of the chemical mixing tank being mounted on the galley over the pump room. This is standard equipment, arranged in the usual manner with the heater on top of the treating tank. Feedwater is heated to a temperature of about 210 deg. The feedwater heater has a capacity of 25,000 gal. per hr.

From the treating tank the water is delivered directly to the boiler feed pumps, of which there are three. These are all Goulds centrifugal units rated as follows:

2—180 g.p.m., 480 ft. head, 1750 r.p.m. 6 stage, driven by 75-hp., 2220-v., 3-phase, 60-cycle, General Electric Co. induction motors.

1—similar unit but driven by a 130-hp. Terry steam turbine.

Under ordinary conditions, the steam-driven unit is used as the exhaust steam is used for heating purposes.

Besides the boiler feed pumps there are also installed in the pump room service pumps, one of which is used for back washing the filters and the fire pump for the entire refinery. The latter is a Goulds centrifugal unit, of 2400 g.p.m., 404 ft. head, driven at 2175 r.p.m. by a 345-hp. Terry turbine. Should the fire pump fail, the steam-driven boiler feed pump is so connected that it can be discharged into the fire line. It thus may be used as an auxiliary fire pump. In a similar manner, the fire pump can be used as a boiler feed pump.

In addition to the above pumps and the chemical mixing tank of the water softening system, the pump room contains an air compressor for supplying air for various purposes throughout the refinery. This is an Ingersoll-Rand cross compound unit, one cylinder 8 by 10 in., the other 13½ × 10, driven by an Electric Machinery & Mfg. Co., 100-hp., 80-per cent power factor, 2200-v. synchronous motor. Excitation for this motor is furnished by a separate motor-generator set located on the gallery above.

The six boilers are well equipped with accessories and instruments for checking operation. For control of water level Copes feedwater regulators are provided. These regulators are fitted with the new type R. G. valves. In addition to the usual water columns for indicating the boiler water level, Combustion Engineering Co. water level indicators are installed on each boiler.

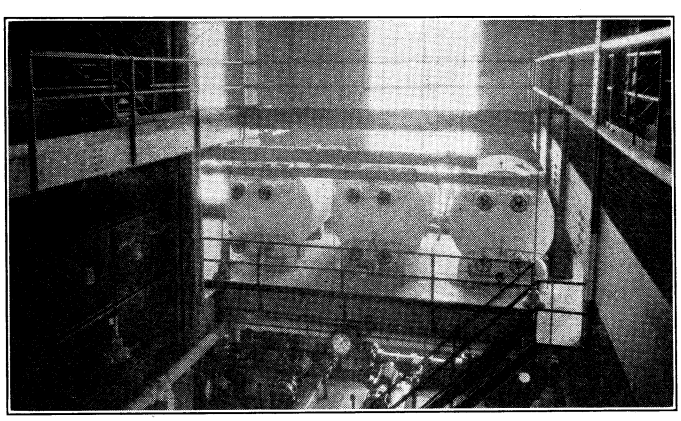


FIG. 4. VIEW FROM THE UPPER PART OF THE BOILER ROOM SHOWING THE FILTERS ON THE BALCONY

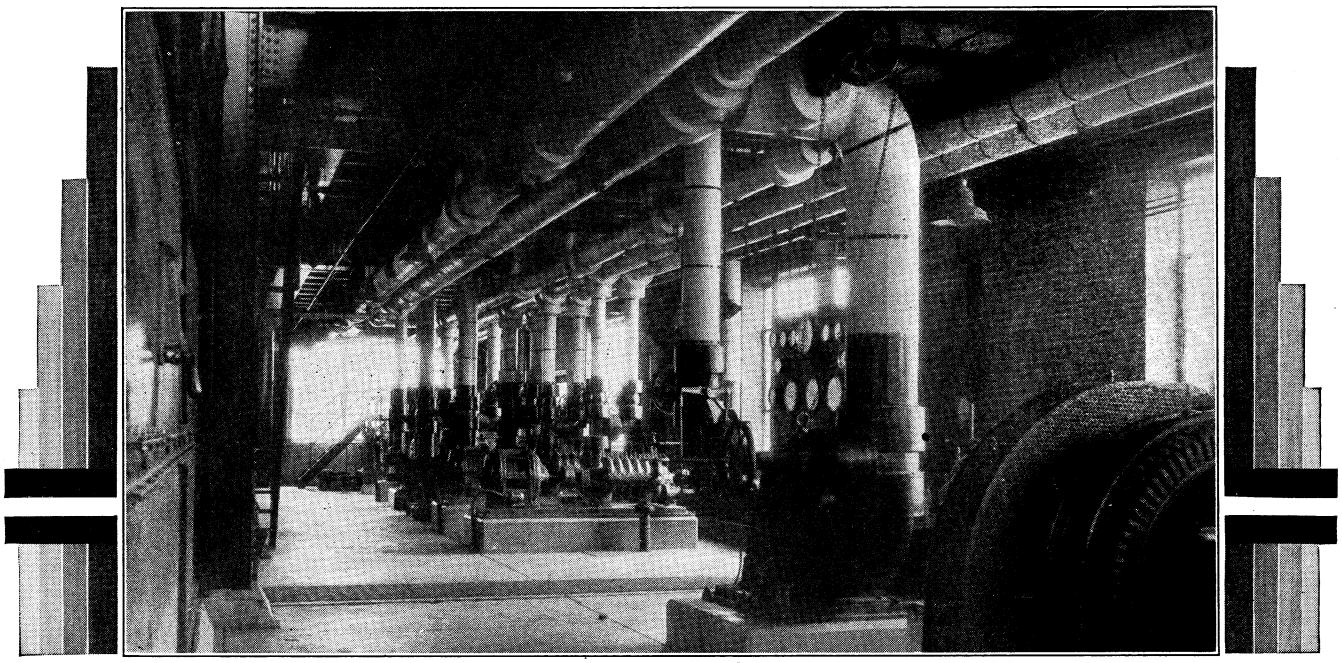


FIG. 5. GENERAL VIEW OF THE PUMP ROOM

These are simple devices, making use of a float in an auxiliary water column, connected to an indicator in a gage glass placed below near the boiler room floor. Since this gage operates in cold water, the life of this glass is long and its convenient location is a great advantage.

Boilers are fitted with Consolidated outside spring type safety valves, Elliott stop and check valves, and Yarway combination blowoff valves.

The blowoff lines discharge into a blowoff tank located below ground outside the building. This tank discharges into the sewer and is maintained partly filled, by means of the discharge from the water jackets of the air compressor cylinders. This water, being quite warm, prevents sudden strains which might be imposed on the blowoff tank by the sudden entrance of the hot blow down water.

Instrument equipment includes a Bailey boiler meter on each boiler, indicating and recording steam flow, air flow, flue gas temperature and indicating the draft in the furnace.

Additional instrument equipment is located on the main boiler gage board. Here indicating meters are provided for measuring, raw water pressure, treated water pressure, exhaust steam pressure, line steam pressure, filtered water pressure, feedwater pressure, air pressure, fuel oil pressure and fuel gas pressure. Other in-

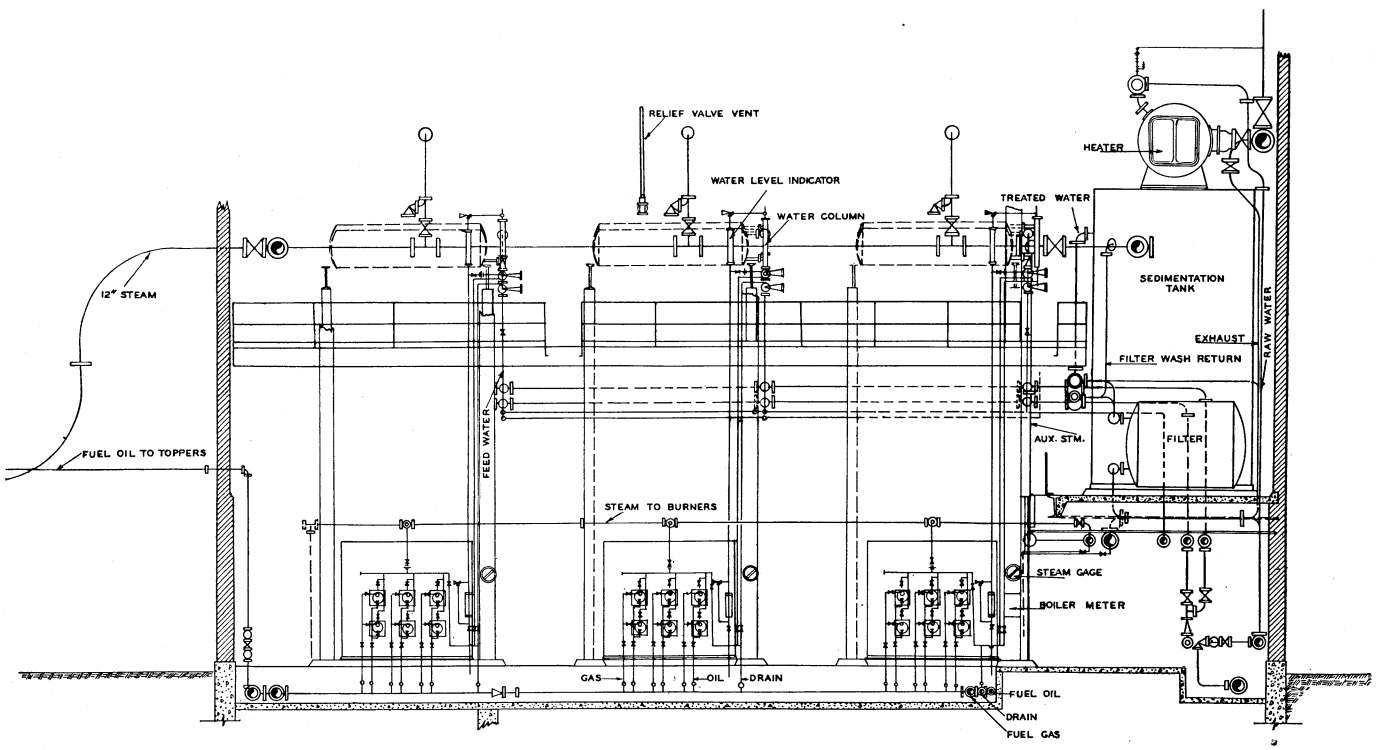


FIG. 6. FRONT ELEVATION OF BOILER PIPING

struments record line steam pressure, water flow and auxiliary steam flow. All steam is metered at the boiler house and again at the various points of use throughout the refinery. The recording meters on the boiler room gage board are Foxboro units and the indicating instruments Crosby.

All fuel oil, water and gas is metered and temperature recorders are placed on the feedwater and fuel oil lines.

All steam is sent to the refinery at 165 to 175 lb. pressure, which will give a minimum pressure at the end of the line of 150 lb. per sq. in. through 12-in. overhead lines. The plant is centrally located with respect to the refinery and distribution is effected with a minimum of pipe lines. The line leaves the boiler house in two directions but connects to form a loop.

The steam, of course, is used in the refinery plant for various purposes,—driving pumps, heating stills, etc. For those who are unfamiliar with the manner in which power is used in an oil refinery a brief description of the process may be of interest. Crude oil as may be known is a mixture of hydrocarbons. The lighter hydrocarbons, that is those containing fewer atoms of carbon and hydrogen to the molecule, have a lower specific gravity and a lower boiling point than hydrocarbons of similar composition but whose molecules contain a greater number of atoms. If a mixture of hydrocarbons be heated in a suitable vessel, the lighter compounds begin to evaporate and volatilize while the heavier hydrocarbons remain as a liquid, due to their different boiling points. The possibility of thus separating the lighter hydrocarbons—fractions—from the heavier ones according to their different boiling points is the fundamental principle in the technology of petroleum refining.

In practice this distillation is accompanied by continuously pumping the crude oil through tubular heaters into the bottom of fractionating columns where vaporization of the lighter fractions is accomplished by the assistance of the introduction of steam. The lighter fractions are then separated in the columns into gasoline, kerosene, furnace oils and the like, while the heavy residue is either sold as fuel oil or charged to the pressure stills for the further production of gasolines and other light oils. The steam used in the distillation is exhaust steam from the pumps, so the major load on the boiler plant is to supply steam for pumping, tank heating and process heating.

In conclusion, it may be pointed out that this plant is well designed for the purpose it is intended to serve. The investment, it is apparent, has been kept down to a minimum while at the same time every precaution has been taken to insure reliability. With the use of certain refinement it is possible a slightly higher economy might be obtained but in a plant of this type, it is always a question as to whether the additional investment necessary for such refinement is justifiable.

The plant was designed and constructed by the engineering and construction department of the Empire Companies at Bartlesville, Oklahoma, under the direction of H. W. Camp. The East Chicago plant is under the supervision of E. H. Roy, to whom, and also Mr. Camp, we extend acknowledgments for coöperation in making this article possible.

Increasing Efficiency by Condenser Maintenance

Methods of Finding and Stopping Air and Water Leakage and Replacing Tubes

FORTUNATELY, condenser leakage tests for bad waters such as salt water and those high in chlorides are simple and comparatively easy to make. The better the circulation water the more difficult the determination is but then leakage with waters of this kind is relatively unimportant.

It is quite evident that this circulation water mixing with the condensate and being returned to the boiler, decreases the boiler feed makeup materially and will affect the boiler or feedwater analysis in proportion to its quantity and impurities. Water measurements and boiler room records are, therefore, of assistance in checking up on condenser performance and should be utilized for this purpose.

Again a constant speed centrifugal hotwell pump capacity will depend upon the suction lift of the pump which is equal to the vacuum minus the head of water on the pump suction. In most installations the water level in the condenser hotwell can be read in the gage glass and as the vacuum is relatively constant the height of the water in the gage glass is proportional to the load. Some operators put a rubber band around the gage glass to mark the normal level at one or several loads. Excessive leakage will be the result in a higher water level for the same load. With variable speed hotwell pumps, the speed of the pump will be increased by excessive leakage but this is more difficult to detect without a tachometer.

Locating Leaks

If the leakage is caused by the failure of one or two tubes, they can easily be located by emptying the water boxes of the condenser, taking off the manholes so that the tube ends are available and maintaining a slight vacuum in the steam space. Often the tube can be located by a hissing sound, by running a dampened hand over the tube ends quickly or by a candle. When maintaining a vacuum in the steam space while the turbine rotor is stationary, the turbine shaft should be packed so as to eliminate air leakage which may cause uneven expansion and distortion for a considerable period afterward and do damage if the turbine were started.

If the leaks are numerous and small, the vacuum method is not entirely satisfactory and the best method is to fill the steam space of the condenser with water almost up to the last row of blades, if possible. Water will run out of the ends of the leaky tubes. This method also shows up the leaky packing and the ferrules on other leaky tubes can be tightened at the same time.

If not too numerous, defective tubes can be isolated by plugging the ends with long tapered wooden plugs driven in almost flush with the end of the ferrule. These tubes can be replaced later when convenient. Spring supported, or suspended condensers must be blocked up so as to support the unusual weight when the steam side of the condenser is filled with water.

Excessive leakage from the water to the steam side of a condenser usually becomes evident to the operating crew before a great while, especially if the increase is sudden, caused, for instance, by a split tube. Changes in the boiler water analysis, condensate pump performance and decrease in the amount of boiler feed

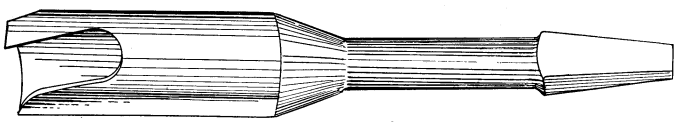


FIG. 1. TOOL FOR REMOVING PACKING

makeup are usually sufficient to tell a wide-awake operator that something has gone amiss. Unfortunately, small leaks, or those that start gradually are not so easily detected. Commercial recording or indicating leakage meters have come into wide use of recent years and plants that do not have them usually make a practice of taking samples of condensate once or twice or several times a day to have chemical tests made.[1]

Air Leakage

Air leakage is not so easily detected nor are the leaks so easily found. Condenser joints, turbine casing, exhaust connections, atmospheric relief valve, low-pressure turbine seal and piping are the most probable points of leakage although porous castings sometimes cause trouble, especially with high vacuums. Little air enters with the steam.

Expansion, contraction and vibration loosen the bolts and heat softens the packing so that periodic inspections are necessary. Constant check should be kept on air leakage and many plants are equipped with air meters, usually so piped that they can be cut in occasionally by the operator as a check on the air leakage.

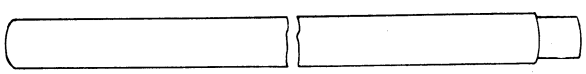


FIG. 2. DRIVING TOOL FOR CONDENSER TUBES

A tight condenser can be operated for a considerable length of time without showing an appreciable drop in vacuum. If, therefore, leakage is suspected it can be checked by closing the valve between the air removal apparatus and the condenser for a certain length of time, say 10 min., and noting the drop in vacuum. By comparing this with readings taken during the same length of time under different conditions, it is possible to get an indication of the relative air leakage.

If after closing the valve the vacuum drops rapidly there is no need to continue the test. The valve should be opened again and the leaks located. This is not always easy, particularly without taking the condenser out of service. If the leak is a large one that has developed suddenly, close inspection at the most obvious points of leakage, with a lighted candle may yield results, although as a rule a candle is not of much service. The best method of checking air leakage while the equipment is in operation is to station an observer at the air pump discharge and then spray oil of peppermint around the places where air leakage is suspected, such as the low-pressure turbine gland, exhaust connections, expansion valves and joints.

[1]See A.S.M.E. power test code on condenser leakage for details.

Condenser Joints

Condenser joints are made up in a number of different ways depending largely upon the manufacturer or individual preference of the customer. Standard practice of one company is to make up condenser joints subject to vacuum by bolting iron to iron, using no gasket but instead a generous coating of red lead.

Other companies use 1/8-in. soft rubber or cloth inserted rubber gasket cut the full width of the flange. This type of gasket gives a tight joint but requires

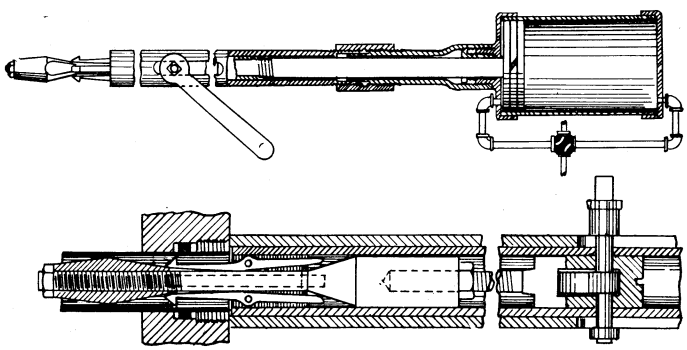


FIG. 3. TUBE PULLER WHICH REMOVES TUBE AND PACKING AT ONE OPERATION

following up a time or two after being placed in service. Where this type of joint fails, the failure is almost always due to the joint not being properly tightened after the packing has had a chance to set.

Perhaps the most widely used joint, both in marine and stationary practice is the heavy duck, 16 oz. is satisfactory, boiled linseed oil soaked in red lead. Like all gaskets subject to vacuum, they should be cut full flange width so that the bolts will keep them from being sucked in in case the joint should open. This type gasket is messy and, due to its flexibility, quite difficult to install. It has, however, the advantage of requiring no subsequent tightening or follow up procedure.

Painting to Stop Air Leaks

For quick starting, the most satisfactory method of minimizing air leaks is to paint all exposed surfaces such as joints and bolt heads with a heavy bitumastic paint. This paint is also useful for stopping up porous places in castings and piping. Red lead and boiled linseed oil mixed with a suitable dryer will also answer the same purpose. It should be spread over the surface where needed, stippled into joints and crevices when the equipment is out of service and allowed to set a few hours before being subjected to a vacuum.

Another method of locating air leaks is by means of the water test such as used for finding tube leakage. The steam space is filled with water as nearly up to the last row of turbine blades as possible. Leaks that occur should be marked with chalk and tightened until the

leaks stop. All piping under vacuum can be given the same test.

Sometimes it is not practical to subject the shell and parts of the system to the water test. In this case, a compressed air test can be used. Usually 5 lb. gage pressure will be sufficient. Leaks can be readily located by going over the castings and piping with a soapsuds solution which can be sprayed on with an atomizer or applied by hand with an ordinary paint brush. This is the most effective, in fact, the only satisfactory method of detecting porous castings and is more effective in locating leaks around valve stems. The water test often gives no indication of leakage at this point because the water swells the packing and stops the leak for the time being.

After a condenser has been heated up either by a shortage of circulating water or after the atmospheric exhaust has opened, the joints should be gone over carefully as expansion and contraction loosen bolts and soften packing. Temperature changes have the same effect on the low-pressure turbine casing. Low-pressure turbine seals should be kept in good condition with plenty of sealing water. The exhaust connection between the turbine and condenser is also a possible point of leakage because it is usually inaccessible and not easily reached for inspection. Low-pressure water connections and atmospheric relief valves are also points to be watched. All vacuum piping should be made up with full width gaskets as ring gaskets can be sucked in and leaks from this source are difficult to detect.

Tube packing dries out quickly when the condenser is out of service or operating noncondensing and after soaking the packing the ferrules should be gone over carefully before the unit is again put in service. Some engineers fill the steam side of the shell with water when the unit is out of service, in order to keep the tube packing from drying and to protect it from high temperatures in case the throttle valve leaked. The same thing can be done when operating the turbine noncondensing, although it is essential that the water be pure so as to avoid corrosion.

When tubes must be removed, the packing can be removed with a tool built like Fig. 1, or with a packing hook as when removing the packing from a valve stem. The easier way, however, is to drive the tube back an inch or so with the tool shown in Fig. 2. The packing can then be pulled out of one end and the tube driven back through the other stuffing-box. A patented tube puller, Fig. 3, has also been developed, this is a device that pulls both packing and tube at the same time.

Expanded tubes are sometimes removed by cutting the tube just inside of the tube sheet either with a torch from the steam side or from the water side with an internal tube cutter with an expanding tool similar to tools used on boiler tubes. The easiest way, however, is to crush the tube with a hammer and chisel and drive it through from the opposite end. Before removing the old tube, a tube guide or small pipe should be inserted in the tube so that the new tube can be replaced without difficulty.

Trends in Steam Turbine Development

Higher Pressures and Temperatures, Increased Capacities, Better Materials, High Efficiency Over Wide Range, Adjustment to Service, Binary Fluids Will Lead to Greater Economies. By A. G. Christie*

PRESENT TRENDS of steam turbine development are towards (a) the use of higher steam temperatures and pressures, (b) increased capacities at the various speeds and increased output from a single casing, (c) the employment of better materials for turbine parts and particularly for blading, (d) higher efficiency over a wide range of load, (e) adjustment of the turbine more closely to the particular requirements of service, and (f) the development of binary fluids for use in turbines.

Higher Temperatures and Pressures

Attention has recently been directed to studies of the effect of higher steam temperatures which conditions present more difficult problems than pressure alone. Tensile strength and fatigue limits decrease rapidly at higher temperatures while the tendency towards that indefinite elongation known as "creep," also increases.

Certain designers have chosen this rate of creep as 0.01 per cent per year, and this or a similar figure may be accepted as a standard rate for high temperatures.

With this rate of creep and with materials now available, turbines can be built for steam temperatures up to 900 deg. F. with assurance of satisfactory operation, while units for 1000 deg. F. can be constructed with every hope of successful operation throughout their useful life.

The application of higher steam temperatures will have a profound influence on future station design. Steam conditions in future stations will probably be standardized as follows: with no reheat 400 lb. per sq. in., 750 deg. F.; and 700 lb. per sq. in., 850 deg. F.; while with one stage of reheat, 1400 lb. per sq. in., 750 deg. F. and 2000 to 2500 lb. per sq. in., 900 deg. F. In the latter case two stages of reheat may be used if high efficiency is desired.

Increased Capacities

Use of turbines of large rated capacities results in several economic gains. Floor space per kw. decreases with increasing size as shown in Fig. 1. Steeple compounding has been introduced to provide a further saving in floor space. The weight per kw. decreases with increased ratings as indicated by Fig. 2. Figure 3 shows that the efficiency also tends to increase with higher turbine capacities though at a lesser rate in the largest units. First cost per kw., in Fig. 4, also de-

*Professor of Mechanical Engineering, The Johns Hopkins University, Baltimore, Md. Abstract of a paper presented Feb. 11, 1931, before the Fifth Midwest Power Engineering Conference, Chicago, Ill.

creases with increased capacity. Economic justification for the trend towards higher capacities is evident from a consideration of these data.

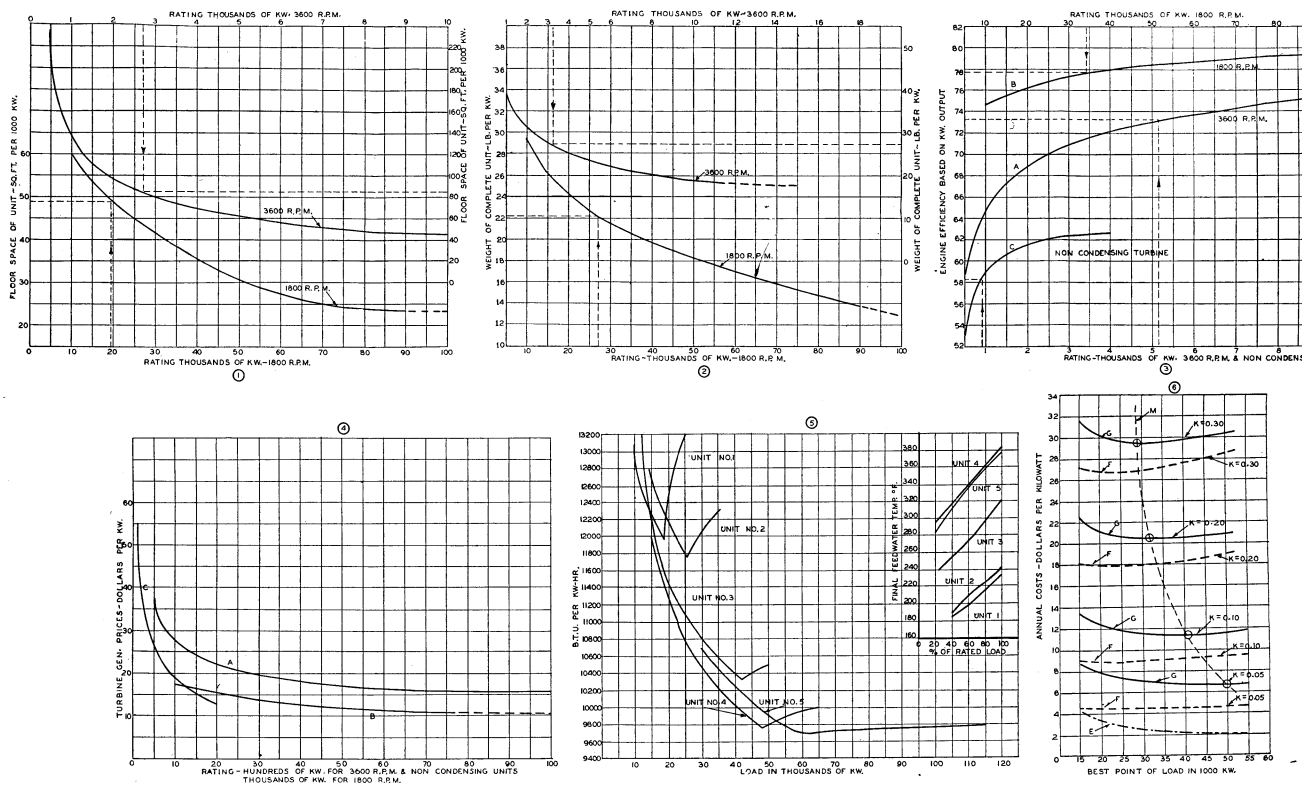
Single cylinder condensing units of 10,000 kw. at 3600 r.p.m. have been built in this country. C. A. Parsons & Co. have single cylinder condensing units of 15,000 kw. at 3600 r.p.m. in operation, one at Regina, Saskatchewan, Canada, and are offering similar turbines of 20,000 and 25,000 kw. with one casing. The largest unit at 1800 r.p.m. with a single cylinder has a capacity of 80,000 kw.

Turbines can be built at 3600 r.p.m. up to 50,000 kw. in two tandem cylinders and up to 100,000 kw. when two low pressure cylinders in tandem are provided. recognized, will lead to a wider use of large turbines at 3600 r.p.m.

Multicylinder units at 1800 r.p.m. have been built in tandem up to 160,000 kw. Such tandem compound units for large capacities will be used more extensively in the future. Triple tandem turbines up to 150,000 kw. at 1800 r.p.m. for 1200 lb. per sq. in. are under construction. Cross compound turbines with several generators ranging up to 208,000 kw. are being used in increasing numbers.

Improved Materials

Manufacture of shafts and turbine discs has been improved through better steel-foundry and forge-shop



FIGS. 1-6. CURVES SHOWING RELATIONS BETWEEN TURBINE CAPACITIES AND DIMENSIONS, HEAT CONSUMPTION AND OTHER FACTORS

Fig. 1. Floor space required for single cylinder, 36000-r.p.m. turbine alternators and also for single cylinder, 1800-r.p.m. units. Fig. 2. Weights of single cylinder, 3600-r.p.m. turbine generators and of 1800-r.p.m. units. Fig 3. Average engine efficiency for the load point of best efficiency based on kilowatt output at the generator terminals. Curve A—Single cylinder turbines at 3600 r.p.m., for steam conditions up to 300 lb. per sq. in. gage, 600 deg. F., 28.5 in. vacuum. Curve B—1800 r.p.m. turbines for steam conditions up to 450 lb. per sq. in. gage, 750 deg. F., 29 in. vacuum. Curve C—Non-condensing units for steam conditions up to 250 lb. per sq. in. gage, 550 deg., F., atmospheric pressure at exhaust. Fig 4. Prices for turbine generator units in the United States. Prices include bare turbine and generator without auxiliary generators or direct-connected exciters and are for units delivered and erected. Prices are for pressures up to 400 lb. per sq. in. gage, steam temperatures up to 725 deg. F. and when condensing, up to 29 in. vacuum. Curve A, 3600 r.p.m.—condensing units. Curve B, 1800 r.p.m.—condensing units. Curve C, Small non-condensing sets. Fig. 5. Improvement in steam turbine performance, from data furnished by Allis-Chalmers Mfg. Co. Unit 1—25,000 kw. at 93 per cent power factor; 350 lb. per sq. in. gage, 675 deg. F., 29 in. vacuum, 2 stage bleeding. Installed 1923. Unit 2—35,000 kw. at 93 per cent power factor; 350 lb. per sq. in. gage, 675 deg. F., 29 in. vacuum, 2 stage bleeding. Installed 1925. Unit 3—50,000 kw. at 85 per cent power factor; 600 lb. per sq. in. gage, 725 deg. F., 29 in. vacuum, 4 stage bleeding. Installed 1927. Unit 4—65,000 kw. at 85 per cent power factor; 600 lb. per sq. in. gage, 725 deg F, 29 in vacuum, reheat to 725 deg F., 4 stage bleeding. Installed 1930. Unit 5—115,000 kw. at 95 per cent power factor, 625 lb. per sq. in. gage, 750 deg F., 29 in. vacuum, reheat to 750 deg. F., 4 stage bleeding. To be installed 1931. Fig. 6. Fixed charges, annual operating costs and total annual costs for turbine-generator with varying use factors and steam costs plotted against various ratings. This reaction turbine has a last blade annulus of 57 sq. ft. Curve E, Annual fixed charges based on 17 per cent of the first cost of turbine-generator installed and including piping and foundations. Curve F, Annual operating costs for various values of the product of use factor and costs per 1000 lb. of steam. Annual Operating Costs = Steam consumption in lb. per kw-hr. at given load as calculated from assumed data ÷ 1000 X 1.025 X cost of steam per 1000 lb. X use factor, X 8760. Curve G, Total annual costs = Curve E + Curve F for each value of K. Curve M, Loci of minimum values of G for various values of K.

These turbine capacities are beyond the limits of any 3600-r.p.m. generators developed to date. These compound units have less weight than a unit of similar capacity at 1800 r.p.m., shafts are shorter and can start under high temperature conditions more rapidly. Efficiencies with the same blade speeds and same kilowatt rating are higher in the 3600-r.p.m. than in the 1800-r.p.m. units. These advantages, when more generally practices, through internal inspection by means of bore holes, through vibrating the discs before assembly, and through careful static and dynamic balancing after completion. As a result of improvements in these practices, troubles with such elements are steadily diminishing.

Stainless steels at present seem best suited for long blades.

Moisture is difficult to remove from this low pressure steam. Different schemes such as drainage grooves, by-pass orifices, etc., have been tried, but the best results so far reported only indicate the removal of about 25 per cent of the total moisture.

Of the various blade materials tried under these conditions, properly heat-treated stainless steels and some nickel alloys seem best. Plating the edges of these blades with erosion resisting metals has been tried and heavy plating of chromium appears promising. Sprayed coatings of tantalum, sheaths of Hecla and other metals, coatings of stellite, and nitriding, also appear to resist erosion and are being further investigated. There is reason to expect that an erosion resisting blading may soon be developed.

Much trouble has resulted from deposits on turbine blading and a technique has been developed to remove this in stations where the deposits are troublesome. Purer makeup for boiler feedwater, less condenser leakage, and drier steam from boiler drums to superheaters, will do much to overcome this trouble.

Improved Efficiencies Over Wide Load Range

Gains in efficiency from improvements in the design will be comparatively small for any particular feature, but in the aggregate may lead to substantial advances. Efficiencies of 82 to 85 per cent at the coupling are obtained on some American turbines while an efficiency of 87.7 per cent at the coupling is claimed for a European turbine of 85,000 kw.

Recent designs provide for high efficiency in B.t.u. per kw-hr. over a wide range of load through the use of secondary, tertiary, and even quaternary inlet valves. This is shown in Fig. 5 where the heat consumption of the largest unit does not vary more than 100 B.t.u. per kw-hr. from 55,000 kw. to 115,000 kw. loads. The governor design becomes more complicated when such additional admission valves must be controlled. Manufacturers provide inherent excess capacity in many turbines so that full load can be maintained should boiler pressure drop below normal. But generators are designed with little spare capacity and if additional overload capacity is desired, this must be specified and paid for, or, the generator may be purchased for a lower power factor.

Successful operation of the high pressure direct contact heaters at South Amboy Station may lead to a more extended use of this type.

The last high pressure heater is frequently furnished with highly superheated steam. It is possible to design a counter current closed heater to take advantage of this superheat and thus raise the feedwater above the saturation temperature corresponding to the steam pressure in this heater.

Warren Viessman and the writer showed in a recent paper* that, after a turbine has been fully loaded with all bleeders in service, still further gains in turbine capacity can be secured by cutting off bleeder heaters at the time of peak load.

Reheating of steam is necessary with pressures of 1200 lb. per sq. in. and above. Flue gas reheating is apparently gaining ground on account of the marked improvement in station economy achieved by its use. Steam reheating is more convenient in certain stations but is less economical than gas reheating. The use of diphenyl-oxide for reheating purposes is being investigated and appears to have interesting possibilities.

The use of hydrogen for generator cooling will probably be the next improvement in turbo-generator construction.

Adjustment of Turbine to Specific Service

The desire to reduce power costs by keeping station investment at a minimum, led to a study of turbine frames and their economic ratings as fixed by their probable use factor throughout their whole operating life, and by the cost of fuel. Figure 6, from a study by Francis Hodgkinson, of Westinghouse Electric & Manufacturing Co., shows that a casing may have an economical rating from a dollar standpoint ranging from 30,000 to 50,000 kw. depending upon the value of K, which is the product of use factor expressed as a decimal, and costs in dollars per 1000 lb. of steam.

Excellent performance of the mercury boiler and turbo-generator plant at Hartford, Conn., has definitely established that combination as a commercial unit.

The success of the mercury turbine will encourage attempts to develop processes to use other materials than mercury such as diphenyl, diphenyl-oxide, and zinc ammoniate.

One will ask, "What is the probable limiting performance to be expected of a steam turbine?" This has not yet been approached, and American economic conditions may never warrant the plant investment to achieve this ultimate end. Probably the best estimate of this limiting performance is that for a large plant with steam at 2500 lb. per sq. in. 1000 deg. F. having two stages of reheating to the same temperature, and with six stages of bleeder heating, leading to a station heat rate of about 9500 B.t.u. per kw-hr. of net output. Within the bounds of our present knowledge, this may be taken as the best performance to be expected of a steam turbine.

Two of the most important and widely used laws of thermodynamics dealing with gases were not discovered until comparatively modern times. The first stating that at constant temperatures the volume of a given weight of gas varies inversely as the absolute pressure was discovered by Boyle in 1662 at the age of 35. This same law was discovered a few years later and independently by the Frenchman, Marriotte after whom it is also called at times. Boyle was born at Listmore, Ireland, and attended Eton. He was a well known chemist and philosopher.

The other law stating that at constant pressure the volume of a given weight of gas varies directly with the absolute temperature was discovered by Charles in 1787 but was not made public until published by Gay-Lussac in 1802. For this reason, it is sometimes called Gay-Lussac's Law, although he gave credit for its discovery to Charles. These two laws are sometimes combined to form the well known expression $PV \div T = a$ constant. Actual gases deviate somewhat from this equation and the term "perfect gas" is sometimes used to express the requirements of a gas that would conform exactly to these laws.

*"Low Cost Peak Load Capacity with Bleeder Turbines" by Warren Viessman and A. G. Christie. Metropolitan Section, A.S.M.E., January 8, 1931. Abstracted in Power Plant Engineering, Feb. 15, 1931 issue.

Pulverization and Boiler Performance

Resume of Theoretical Studies and Actual Tests as Affecting Design of Pulverized Coal Furnaces, Mills and Boiler. By E. H. Tenney*

IN THE last six years, during which time the use of pulverized coal in the operation of large boiler furnaces has been greatly increased, the question has been repeatedly raised as to the relationship between the degree of pulverization and boiler performance. In a general way, it seems to have been agreed that coarse pulverization results in unsatisfactory and incomplete

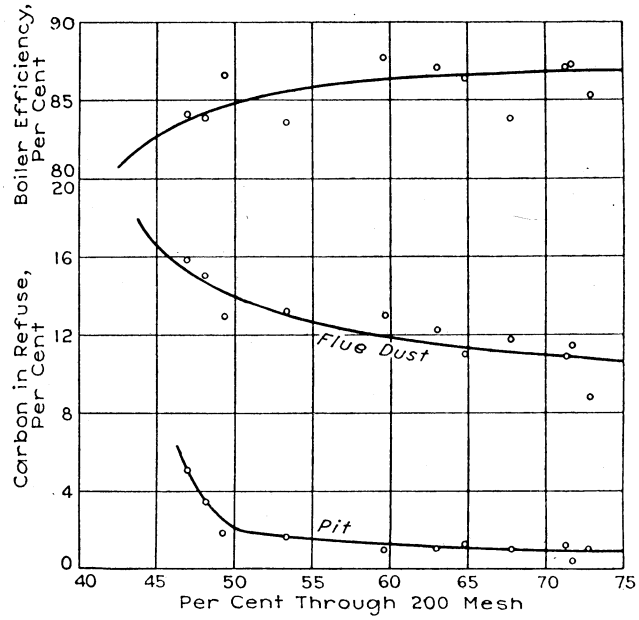


FIG. 1. BOILER EFFICIENCY AND CARBON IN REFUSE PLOTTED AGAINST DEGREE OF PULVERIZATION, BOILER NO. 17, CAHOKIA STATION

combustion in the furnace, and that the finer the coal is ground the better the resulting furnace condition.

Theory of Particle Size

Since the size of the coal particles affects nearly every phase of pulverized-fuel firing, the various steps in the process and their relation to particle size must be considered.

Delivery of the fuel particles into and through the furnace is dependent upon the dust-bearing capacity of the air stream. For example, if the horizontal velocity of gases in a furnace is 10 ft. per sec., then particles over a 50-mesh sieve, or larger than 0.006 in. diameter, will settle out to the furnace bottom. Thus there is at once a definite limitation to the size of particles, for the coal must be maintained in suspension while being burned.

The burning process is effected in two steps: (1) the heating and ignition of the dust cloud, and (2) the subsequent combustion of the dust particles.

The rate at which the dust cloud becomes heated to the ignition point depends upon these factors:

(1) The temperature of ignition source (i.e., the temperature of the combustion chamber) and the position of the furnace heat-reflecting surfaces.

(2) The temperature to which the air and particles are preheated before entering the furnace.

(3) The thermal capacity of the dust cloud—which accounts for greater or lesser temperature rise with addition of a given quantity of heat, and which is increased by excess air.

(4) Rate at which heat is conducted to the interior of the particles, which Dr. Rosin† connects with the time lag of ignition.

(5) The opacity of the dust cloud, which increases its rate of radiant-heat absorption.

Of these perhaps only the last two are dependent on fineness.

The combustion of the ignited particles requires a considerably longer time period than their ignition, and is therefore relatively more important in seeking high combustion intensity and consequent reduction of furnace size. The rate of combustion may be considered as dependent upon two factors: (1) the combustibility of the coal (or rapidity of its reaction with oxygen) which is generally higher for low-rank fuels of high reactivity, and (2) the rate of contact with oxygen at the interface between the dust particle and the air supply.

The relation between furnace temperature and combustion time is shown for three finenesses. The surprising result is that the higher the combustion chamber temperature the slower the combustion, i.e., the temperature coefficient is negative. The explanation for this relation given by Dr. Fieldner is that coke formed from coal at higher temperatures is known to be less reactive than coke formed at lower temperatures, and in the pulverized-fuel furnace the particles are first formed to coke during the combustion cycle. The higher-temperature furnace consequently results in slower burning. The negative temperature coefficient is exactly opposite to the accepted opinion and should be substantiated, but if and when it is substantiated, then another reason exists, in addition to that of Dr. Rosin,† for lower furnace temperatures.

Chemical reaction between oxygen and the dust particle is so rapid that the rate of delivering the air supply to the particle is probably more important than the combustibility of the coal. This rate of oxygen reaction is dependent upon these factors:

(1) The specific surface of the dust (ratio of the area of coal to its mass).

(2) The proportion of air mixed with the dust and the manner in which it is supplied.

(3) The temperature of combustion space, which also determines the rate of chemical reaction between the fuel and air.

*Chief Engineer of Power Plants, Union Electric Light & Power Co., St. Louis, Mo. Abstract of a paper presented Feb. 12, 1931, before Fourth National Fuels Meeting, A.S.M.E., Chicago, Ill.

†Paper before International Conference on Fuels, Dr.-Ing. P. Rosin, abstract in Power Plant Engineering, March 15, 1930, p. 326.

(4) The relative motion between the dust and the air.

One final factor in the subject of fineness of grind assumes considerable importance in practice, i.e., the effects of very coarse particles of slag "birdnesting" in the boiler generating tubes. Apparently results in commercial installations alone can establish the limitations on this point. The fusing of the ash, the path of the gases through the furnace, and the furnace shape all have a bearing on results. The slagging tendency has had much to do with the limit of 1 to 2 per cent over 40 mesh generally established by operators. On the other hand, recent developments in flame directions and in arrangement of boiler tubes to avoid birdnesting have been quite effective. Three methods may be used separately or together: (1) wide spacing of lower generating tubes to prevent slag bridging over and to chill to solidity the heavy particles of molten ash, (2) directing the flame toward the hearth in slag-tap furnaces so as to throw out the heavy particles which are then burned on the floor, and (3) the use of properly placed slag blowers. These devices as applied commercially must be watched for developments.

The problem of "what fineness of grind to design for" in a proposed installation is one which at present can be solved only on the basis of what previous experience indicates is desirable. In general, the furnace must be sufficiently large to permit complete combustion of the larger particles, or, conversely, the fineness need be no greater than furnace volume and burning time requires. Although the experimental work previously referred to suggests that these considerations would permit a wide range of fineness for different fuels and furnace temperatures, practice is in general uniform, with most installations working on about 65 per cent through 200 mesh, with over 40 mesh limited to 1 to 2 per cent. Yet with this uniform fineness maximum heat liberations range from 12,000 B.t.u. per cu. ft. per hour to 50,000 in central-station practice and up to 100,000 and higher in marine and locomotive practice. This represents a range in burning time from 3 sec. down to 0.7 sec. for central-station practice, and fineness should vary accordingly. In other words, there are installations where furnaces are either four times as large as theory indicates or coal is being ground to 200 mesh when less than 100 mesh might suffice. The problem quite apparently warrants further attention and study, both by designers and by operators.

Cahokia Tests

The problem as to what fineness to use in a plant already in operation usually becomes one of balancing costs of coal preparation against savings in boiler efficiency. The case of boiler economy versus preparation costs, was the subject of a number of tests which were made at Cahokia Station.

A series of economy tests were made on No. 17 boiler unit, which is an 1801-hp. cold-bottom unit, fired from two 15,000 lb. per hour Simplex unit mills. It was found that at the normal rating of 300 per cent (furnace liberation of 20,000 B.t.u. per cu. ft. per hour) a wide range in fineness could not be fired because the mills, fans, and burner piping were designed for comparatively fine coal and became choked with large quantities of coarse coal. To permit a range of 45 to 75 per cent through 200 mesh, it was therefore necessary to operate at about 200 per cent rating, or 13,000 B.t.u. furnace-heat liberation. To this extent the tests are of more value for study than for practical use in establishing regular plant practice. The wide range of fineness, however, gave an interesting set of conditions to observe.

Test results are plotted from a table in Fig. 1. A high CO_2 of 17 per cent (18 per cent excess air) was held throughout. This point was determined by smoke, the air adjustments being made to avoid unburned hydrocarbons. In this way all the loss due to incomplete combustion was evident as unconsumed carbon in flue dust or ashpit, which reaches 15.7 per cent and 7.0 per cent respectively with the coarsest coal.

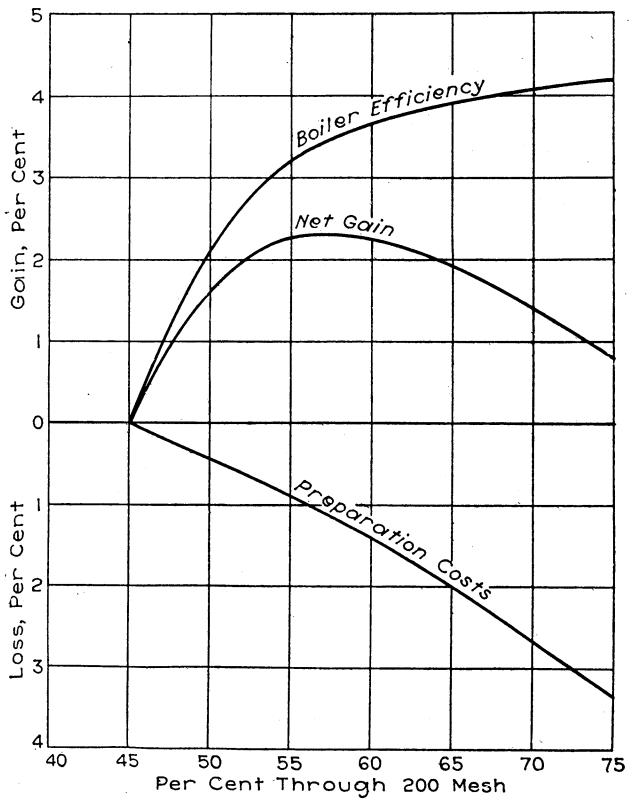


FIG. 2. PER CENT GAIN OR LOSS IN BOILER EFFICIENCY AND COAL PREPARATION COSTS PLOTTED AGAINST DEGREE OF PULVERIZATION, BOILER NO. 17, CAHOKIA STATION

Points boiler efficiency gain from upper curve Fig. 1. Loss due to extra coal-preparation costs shown as per cent of cost of coal and equated to equivalent per cent points of boiler efficiency. Lower curve subtracted from upper to give net overall gain expressed in equivalent per cent points of boiler efficiency.

There has previously been shown the relation between particle size and gas velocity necessary for combustion in suspension. At the rating at which these tests were made, between 3 and 4 sec. are available for combustion and the flame travel is about 40 ft. or 10 to 13 ft. a sec. Particles between 40 and 50 mesh, therefore, would tend to fall to the furnace bottom. This is borne out by the test data.

The boiler efficiency, of course, summarizes all losses and, allowing for test inconsistencies the net result is shown by the upper curve, Fig. 1. There is no gain when the fineness exceeds 65 per cent through 200 mesh. The central curve in Fig. 2 represents the net gain and the best point of operation is at 57 per cent through 200 mesh.

Combustion Conditions in Engines

Chart Aids in Interpreting Compression and Expansion Curves of Internal-Combustion Engine Indicator Diagrams

By Robertson Matthews

POSSIBLY because of the smallness of the fuel bill of internal-combustion engines as compared with that of many steam power plants, the operator of such engines often has not been provided with certain useful instruments for directing the achievement of fuel economy as has the steam engineer. There may be a tendency also to consider internal-combustion engine operating conditions as more readily and definitely fixed.

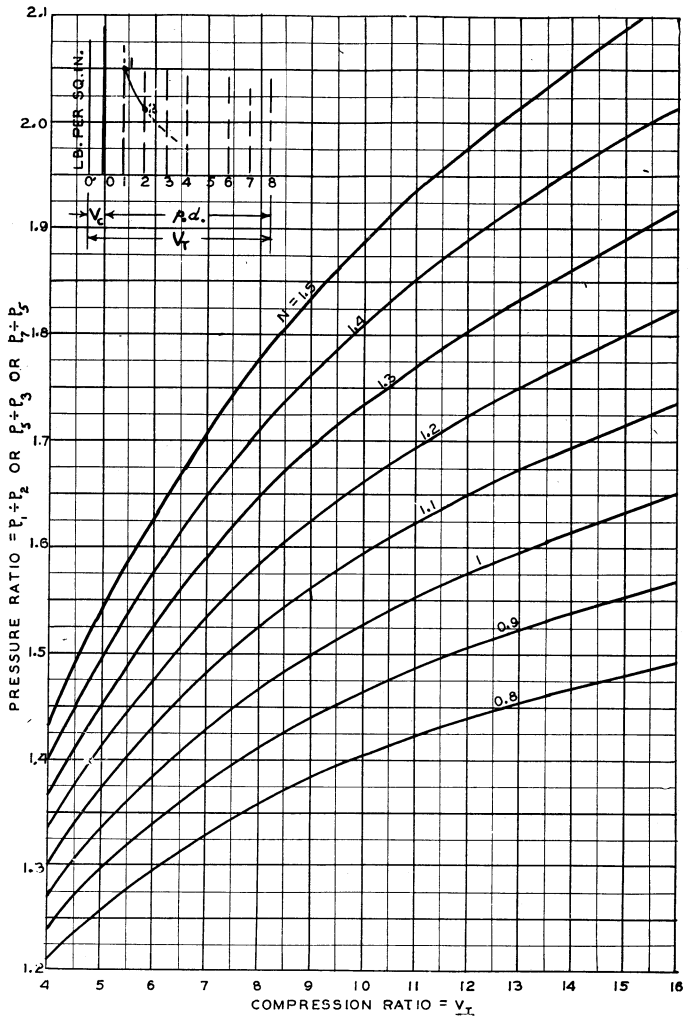
Apart from a pyrometer and a pressure-volume indicator, however, the internal-combustion engineer has nothing provided him to show what the combustion conditions may be under a prevailing short change of load, engine conditions or settings or of quality of fuel. In this situation, attempts have been made to obtain as much information as possible from the indicator card. Here, however, findings are open to criticism concerning accuracy, whence the indicator card becomes more of a comparator than instrument of precision.

The "n" chart cannot correct for inaccuracies in indicator operation but it can both reduce errors often credited to some methods of utilizing the indicator cards for comparing results and expedite such determinations. For example, assume that a set of cards have been obtained during a test which showed favorable fuel consumptions. Similar cards should again represent favorable fuel consumptions; but is the eye or the planimeter or the point of cutoff sufficient guarantee of similarity?

A further prompt check is possible. Does the pressure drop during expansion of the gases occur at the same rate on these supposedly similar cards? This pressure drop is represented by the "slope" of the expansion curve, which mathematically is represented by the value of "n" in the equation PV^n = a constant.

With variable loads the areas of the cards will be different. The slope, however, of expasion lines that represent good combustion at normal load should be approached when the card areas are either somewhat greater or somewhat less. Exceptions occur when loads are reached where the cylinder-wall cooling effect becomes disproportionate to the heat from the fuel, which condition will increase the value of "n"; and where the injection timing and the large amount of fuel injected creates late burning, which condition causes the value of "n" to approach a value of one.

Assume the pressure-volume indicator card has been divided lengthwise into eight equal parts. That is, the piston displacement has been divided into eight equal parts. On oil engine cards, especially, conditions during the first eighth of the expansion line are likely to include considerable irregular combustion, hence this part of the expansion curve, in but few cases, will have



MATTHEWS "N" CHART AIDS IN INTERPRETING CURVES

an exponent approaching anywhere near a constant value of "n"; and we are badly in need of something more than an indicator card to yield interpretation of the expansion line conditions in that region.

From piston positions 1 to 2, expansion conditions should be more stable in good engines. Hence, measure the absolute pressures at points 1 and 2. Then find the ratio of p_1 to p_2. For example, say it is 1.75. Then with the volumetric ratio of known compression, say 14 for this example, look for the intersection of the 1.75-line and the 14-line. This intersection lies at a point about two-thirds, or say 0.6, the distance between the 1.1 and 1.2 curves, or "n" is approximately 1.16. This value of "n" shows combustion is not yet complete since with no combustion to add heat to the gases, the value of "n" would be nearer 1.3. From positions 1 to 2, the cylinder is colder than the gases and tends to cool them by some amount in addition to the amount of heat converted into work of expansion.

Similar procedure applies to those portions of the curve lying between, say, division lines 3 and 5 and also that portion between division lines 5 and 7. Cards have been studied where "n" in the region 5 to 7 has approached a value of 1. The corresponding fuel consumption was found to be much over 1 lb. per br-hp-hr. This late burning might have been due to too late injection. The value of "n" for the compression curve can be found in like manner for such portions as give pressure ratios of such values as occur on the chart.

Electricity---What It Is and How It Acts*

PART XLVIII. VARIOUS METHODS OF STUDYING CRYSTAL STRUCTURE BY X-RAY ANALYSIS. BY A. W. KRAMER

THE LAUE PHOTOGRAPHS referred to in a previous chapter are due to the diffraction by the crystal of the so-called "white" or general radiation proceeding from an X-ray tube. It may be recalled from the discussion of the production of X-rays[1] that the radiation proceeding from an ordinary X-ray tube consists, not of waves of a single frequency but of various frequencies. In fact, the radiation from such a tube consists of waves of every possible length from the longest X-rays known, down to a limit which is determined only by the voltage across the tube.[2] The radiation, thus, may be compared to "white light, for this we know is also composed of waves of all lengths.

In examining this general radiation from an X-ray tube, however, it will be found that a single frequency predominates, just as in the visible spectrum of an incandescent element certain frequencies predominate which serve to produce the line spectra of that element. And as in the case of light, these line spectra serve to identify the element producing them, so in X-rays, the line spectra or single frequencies which are superimposed upon the general radiation, serve to identify the element out of which the target in the X-ray tube is made. In other words, for every element, tungsten, platinum, etc., there are groups of wave lengths which are characteristic of that element. These groups are called the K, L, M and N series and represent the energy levels of the electrons in the atom as explained in a previous chapter.[3] The target of an X-ray tube emits wave lengths of a given one of its characteristic series with relatively large intensities when the voltage across the tube exceeds the quantum limit for the shortest waves of that series. The effect is as though the characteristic rays were superimposed on the "white" X-rays.

These peculiarities of X-ray spectra have been utilized by one or another of the various methods of X-ray crystal analysis. So far we have only considered the Laue method, but others have been developed which are more suitable for certain purposes. In the Laue method the effect of the entire general radiation is utilized. In the powder method to be discussed later, only one of the characteristic wave lengths is employed. In another only the limiting (the shortest) wave lengths are used.

In the Laue method, when the crystal is placed in the path of "white" X-rays it will in general diffract some of the X-rays for no matter what plane of atoms in the crystal may be inclined to the beam, there will be some wave lengths present which will require just that grazing angle of incidence for diffraction from that family of planes. In other words, for any value of d and Θ in the equation,

$$m\,L = 2\,d\,\sin\,\Theta$$

which was referred to in the preceding article there will be a wave length in the range of wave lengths present in the incident beam which will be diffracted and thus give evidence of that value of d and Θ.

Since the atoms have orderly arrangements in all three dimensions of space it follows that diffraction of X-rays will occur from many families of atomic planes at once, *each family picking out the wave length which it can diffract at the angle at which it finds itself.* This is shown diagrammatically in Fig. 1, which is a curve representing the distribution of wave lengths in a diffractent beam of X-rays. The curve, as will be noted, is characterized by high, sharp peaks, these peaks representing the wave lengths most effectively reflected from the planes in the crystal.

In the Laue photographs, these peaks appear as spots of light which arrange themselves in the form of a pattern around the central primary beam. The crystal is mounted so that one of its faces is perpendicular or nearly perpendicular to the direction of the incident primary beam. This setting is accomplished by direct observation of the faces of the crystal by ordinary crystallographic methods. This makes it possible to calculate at once the angle of grazing incidence between the incident beam and any atomic plane which may be assumed to exist in the crystal. In this way each spot on the photograph may be referred directly to the family of planes which give rise to it. By careful measurement

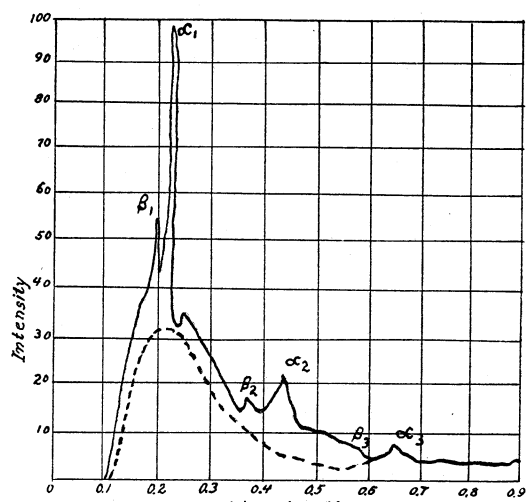


FIG. 1. DIFFRACTION OF "WHITE" X-RAYS BY A SINGLE CRYSTAL

*All rights reserved.

[1]Part XXVII, September 1, 1929. Page 963.

[2]This limiting wave length L_0 may be calculated at once from the voltage across the tube by the quantum equation,

$$L_0 = \frac{h\,c}{E_1\,e}$$

where h = Planck's constant, 6.55×10^{-27} erg./sec.
c = the velocity of light in vacuum, 3×10^{10} cm. per sec.
E = the potential across the tube in absolute electromagnetic units, = volts $\times 10^8$.
e = the charge on the electron in absolute electromagnetic units, $= 1.591 \times 10^{-20}$ a.e.m.u.

Since e, h, and c are all constants, the equation may be written,

$$L_0 = 1.234 \times 10^{-4}\ E_2^{-1}$$

in which E = the potential across the tube in volts.

[3]Part XXVII, September 1, 1929. See Fig. 6.

of the angles between the crystal and the spots in the photograph, the atomic planes can be determined and a model of the crystal may be constructed.

By this method, the arrangement and spacing of atoms in various substances have been determined with great accuracy.

In the Laue methods, as stated above, a beam of "white" or polychromatic X-rays is used, and the spots produced are due to the relation existing between certain wave lengths of X-rays and the angles of certain of the atomic planes.

It is evident, therefore, that a similar result could be obtained if, instead of "white" X-rays, a monochromatic ray is used and the crystal slowly rotated. This is the method devised by Sir Wm. Bragg and is known

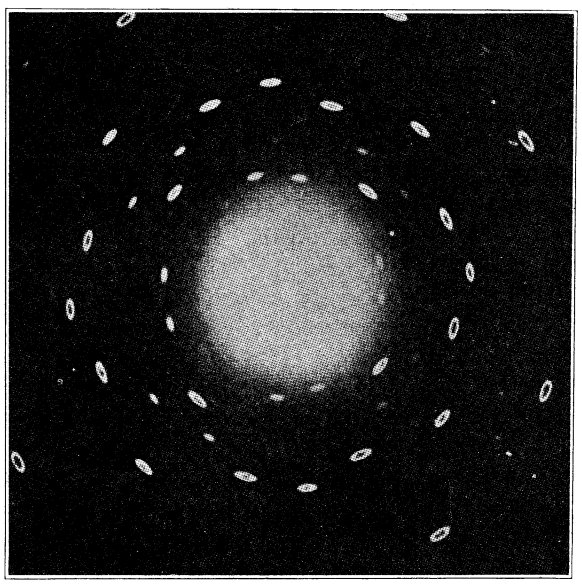


FIG. 2. A TYPICAL "LAUE METHOD" PHOTOGRAPH. THIS IS THE LAUE DIAGRAM FOR MAGNESIUM OXIDE

as the Bragg method. The apparatus involved is shown in the diagram, Fig. 3.

Rays from an X-ray tube enclosed in a lead chamber pass through a selective screen, which passes only waves of a definite frequency and the monochromatic ray thus produced falls on a crystal. The latter is so mounted that it can be rotated through any angle. Upon so rotating the crystal, the intensity of the refracted beam which enters the irrigation chamber varies, disclosing the angles at which the greatest refraction takes place.

Another method using monochromatic X-rays is the so-called "powder" method developed independently by Hull, Debye and Scherrer. This method was devised largely in order to investigate materials which ordinarily are not obtainable in the form of single crystals large enough to adapt them to the Laue or Bragg method. This method utilizes crystals which have been crushed to such a fine powder that the fragments have random or chaotic orientation.

Such a powder requires no rotation for, since every atomic plane is present in every possible orientation, there must be some individuals from each family of planes which are oriented at the correct angle to diffract the monochromatic X-ray beam. If the volume of powder used is large enough and the fragments are

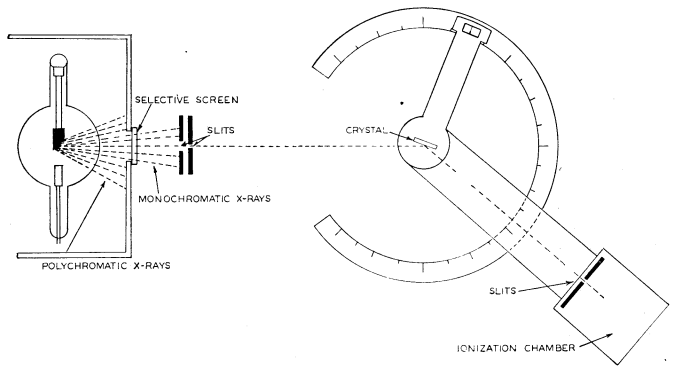


FIG. 3. THE X-RAY SPECTROMETER AS USED IN THE BRAGG METHOD OF CRYSTAL ANALYSIS

Polychromatic X-rays emitted by the tube are passed through a screen to produce a monochromatic beam which is diffracted by the crystal into the ionization chamber.

sufficiently small, there will be for any given family of planes, many individuals correctly oriented so that the combined effect for any one plane is much the same as might be expected from a large single crystal having the same orientation. Experimentally it is found that if the powder is fine enough so that it will pass through about 200-mesh bolting cloth and that it is sufficient if it will fill a cylindrical container about ¾ mm. in diameter and about 10 mm. long, that is a volume of about 5 cu. mm.

With this method which is used to a considerable extent, since every atomic plane in the powdered crystal has some representation at the correct angle for diffraction the whole diffraction pattern may be photographed simultaneously.

In Fig. 4 are shown the three methods of crystal analysis together with the type of photograph produced by each method. In the first method (the Laue method) the pattern consists of spots arranged in concentric circles around the central primary beam. The spot pro-

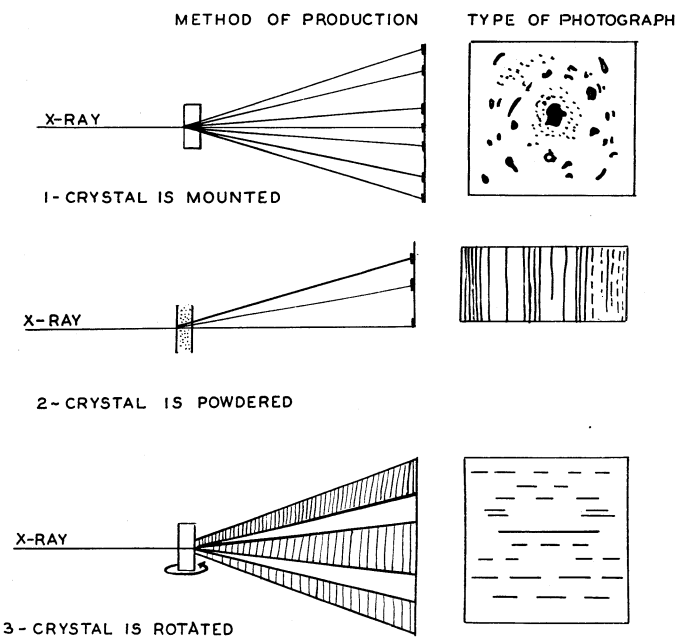


FIG. 4. THREE METHODS OF PRODUCING CRYSTALLOGRAMS

1. The Laue method using a single crystal and a polychromatic X-ray. 2. The powder method utilizing monochromatic X-rays. 3. The method in which the crystal is rotated.

duced by the central primary beam is often rendered less intense by interposing screens between the plate and the beam.

The second method (the powder method) produces a series of concentric rings. Since these rings are the same throughout the whole of their circumference, only a small section is needed for purposes of analysis, hence, the photograph is made usually on a narrow strip of film and the resulting pattern looks very much like the

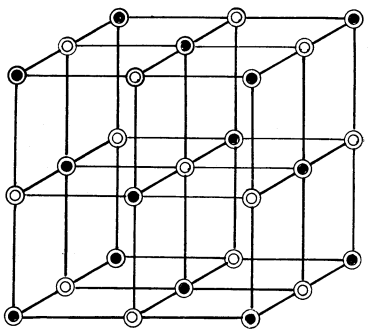


FIG. 5. THE ATOMIC STRUCTURE OF SODIUM CHLORIDE

ordinary line spectra produced by the ordinary spectroscope. The third method, utilizing the rotating crystal, produces a series of long and short lines arranged in parallel rows.

So much for the methods by which the crystal structure of various substances are investigated. We need not follow the intricate patterns produced by these methods nor the still more complicated mathematical analyses to which they give rise. The details of crystal structure analysis by X-rays is a subject in itself on which many books have been written and we need not concern ourselves here with more than a statement of the principle. It is needless to say that these methods have been of tremendous importance and today we know with a fair degree of assurance the actual arrangement of the atoms in many substances. Thus, the sodium chloride structure is that shown in Fig. 4. In this

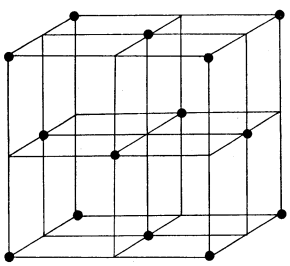


FIG. 6. FACE CENTERED CUBIC LATTICE

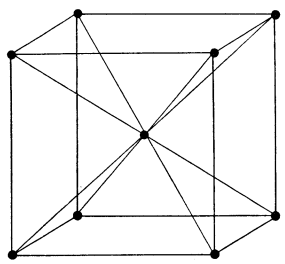


FIG 7. BODY CENTERED CUBIC LATTICE

diagram, the white centered circles represent sodium (Na) atoms and the black centered circles chlorine (Cl) atoms or vice versa. Each atom of one kind is completely surrounded by six atoms of the other kind which mark the points of an octahedron with the first atom at the center. This arrangement is known as the simple cubic lattice and is one of the most common. It is found most frequently in highly polar[4] compounds. It should be noted that each atom is related in exactly the same way to six atoms of the other kind. It thus appears that no particular sodium atom is joined to any particular chlorine atom to form a molecule of sodium chloride. In our consideration of conduction in liquids,[5] we learned that the normal sodium with 11 external electrons has an electropositive valence of 1 and the normal chlorine atom an electronegative valence of 1; hence, it follows that these two atoms have an affinity for each other and together they form a neutral molecule of sodium chloride (NaCl). In a crystal, since each atom is completely surrounded by six atoms of the other kind, it is unreasonable to say that any one of those six combines with the first to form a molecule rather than any of the remaining five. Insofar as a crystal is concerned, the idea of the molecule does not hold, that is crystals are composed of atoms in various combinations, not of molecules.

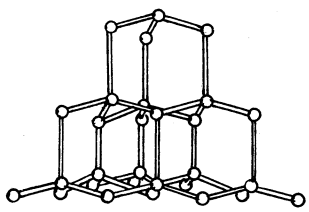


FIG. 8. THE ATOMIC STRUCTURE OF THE DIAMOND

Another type of crystal structure is shown in Fig. 6. This is known as the face centered cubic lattice of which the structure of copper, silver, gold, aluminum, nickel and platinum is typical. With this arrangement, in addition to the atoms forming the corners of a cube, there is an atom centered in each of the six faces of the cube.

Still another lattice type, shown in Fig. 7, is known as the body centered cubic lattice and is represented by iron, chromium, tungsten, etc. Other lattice structures are more complex—the diamond for instance consists of carbon atoms arranged as shown in Fig. 8.

In a similar manner, the atomic arrangements of many substances have been reconstructed and the knowledge so gained is becoming of increasing importance in many fields, particularly that of metallurgy.

[4]A polar compound is one that may ionize when dissolved or fused. In general, all inorganic acids, bases, and salts belong to this group in which the atoms are supposed to be held by electrostatic union.

[5]Chapter VII.

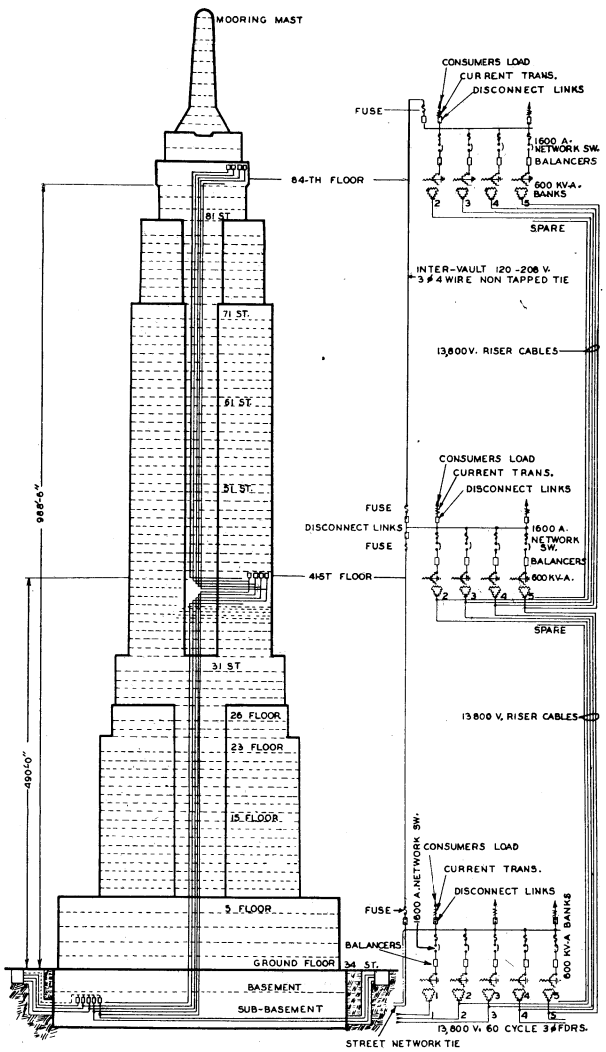
HEAD SHAFT is the term for the first receiver of power from the prime mover—engine or turbine. It transmits the entire load. Jack shafts are intermediate to transmit power from a head shaft to line shaft or between line shafts when the distance apart or conditions are such that a single belt span will not work well. Line shafts are general distributors of power to jack shafts and machines. Counter shafts control speed and direction of the driven machines, usually by step cone pulleys and by clutch pulleys with direct and crossed belts.

IT IS UNNECESSARY to enumerate the advantages of insurance as a protection feature or inspection service because the wide-spread news of boiler insurance shows that its advantages are fully appreciated by the majority of engineers. It would pay many of them, however, to look a little further into other forms of insurance as the advantages of boiler insurance apply equally well to other equipment in the plant.

Program of Varied Interest at A. I. E. E. Meeting

OVER 1500 ELECTRICAL ENGINEERS ATTEND WINTER MEETING OF A.I.E.E. AT NEW YORK, JANUARY 26-30

AS HAS BEEN the custom for many years, the winter convention of the American Institute of Electrical Engineers was held in New York at the Engineering Societies Building the last week in January.



FLOOR	TOTAL INSTALLED TRANSFORMER CAPACITY	CONNECTED LOAD		ESTIMATED DEMAND
		LIGHT	POWER	
64 TH	2400 KV-A.	1545 KW*	3417 HP.	1800 KW.
41 ST	2400 "	1673 KW*	2736 HP.	1664 KW.
SUB BASEMENT	3000 "	2591 KW*	3440 HP.	2311 KW.
TOTAL NON-COINCIDENT SUMS				
	7800 KV-A.	5809 KW.	9593 HP.	5775 KW.
* BASED ON 2 WATTS PER SQ. FT. OF FLOOR AREA.				

DIAGRAM OF EMPIRE STATE BUILDING SUBSTATION CONNECTIONS

It was a week of varied interest for those attending, the technical papers ranging from those having to do with the control of automobile traffic by photocells to those dealing with the revision of magnetic circuit units. In addition to the technical sessions, there were many interesting inspection trips to various points and projects of interest and purely entertainment and social features were not lacking. The meeting was exceptionally well attended, over 1500 having registered.

The annual winter meeting of the Institute is an educational course in itself and while it is true the technical papers presented there are available to the membership as a whole, it is to be regretted that all members of the Institute cannot be present at this meeting to absorb the spirit in which the meeting is held. It is true that only a small portion of the total number of papers presented at a meeting can be adequately digested or even generally understood by the majority of engineers attending, yet it should be something of an inspiration to any electrical engineer to contemplate the breadth and scope of the field in which the electrical engineer of today is engaged.

The quantity of highly valuable technical information released at such a meeting is truly enormous. At the meeting just past, for instance, 52 separate papers were presented at the ten sessions constituting the technical part of the program, an average of 5.2 papers per session. When it is considered that the average length of a session is approximately 2½ hr., it gives each paper a total time of slightly less than a half hour for presentation and discussion and this certainly is not much. It is to be regretted that the discussions at these meetings must be so limited, for often it is in the spontaneous discussion to which the papers give rise that the greatest interest of these meetings lies. Each year it seems, because of the steadily increasing number of papers presented, the actual presentation becomes more and more a matter of routine and the opportunity for discussion becomes less and less.

The meeting was formally opened Monday afternoon, January 26, with an address by the president, W. S. Lee. Mr. Lee, among other things, stressed the duty of the engineer to acquaint the general public with his work and to exert his efforts to see that authentic information in regard to public projects is broadcast. He called attention to the danger of government ownership of power projects and cited Muscle Shoals as an example of unwarranted waste of public funds and gross inefficiency. The total cost of the Muscle Shoals development to date, Mr. Lee said, was $47,000,000 and the development as planned is only about half complete. When completed, the plant will not be worth $30,000,000. Today it has a total primary horsepower capacity of 100,000. Here then is a 100,000-hp. plant worth at the most $30,000,000 for which over $47,000,000 has already been expended and although it is 15 yr. since it was started, no contracts have been made and today is earning nothing.

Conditions such as these, said Mr. Lee, should serve as a warning against the government undertaking the development of the St. Lawrence River power project. At the present time, it is impossible to transmit power to New York from the St. Lawrence on a basis to compete with economical steam plant operation.

Mr. Lee's address was followed by a symposium on telegraphy. Because of the attention given radio and

telephone it might seem that telegraphy had been left behind and that it was subject to little further development. A consideration of the papers presented at this session, however, serves to show that this is not so. Telegraphy shows no signs of age. It is true that in the first 20 yr. of its existence as an art, under the influence of such geniuses as Lord Kelvin, telegraphy became a highly perfected art and so it was not until recent years when new materials and new principles came into existence that further development was possible.

Today, due to the introduction of such materials as Permalloy and devices such as the vacuum tube amplifier telegraphic communication both submarine and land line, has been speeded up tremendously. This was made evident in a paper, describing the Newfoundland-Azores High Speed Duplex Cable, by J. W. Milnor and G. A. Randall, both of the Research Department of the Western Union Telegraph Co. This cable is unique in that it consists of a combination of non-loaded and loaded cable, the latter being tapered throughout certain portions. By means of this arrangement, it has been possible to secure duplex or two-way operation at a speed of 1400 letters per minute in each direction. In a companion paper, Mr. Milnor discussed the influence of interference on submarine cable telegraphy.

Another paper of interest at this session was one by F. B. Bramhall of the Western Union Telegraph Co. describing a telegraph transmission testing machine. With this extremely versatile instrument, time intervals of one ten thousandth of a second in the opening and closing of electrical circuits are graphically recorded without resort to photographic means.

The two remaining papers presented at this session were one by Wm. B. Blanton of the Western Union describing a printing telegraph concentrator and one by R. E. Pierce of the A. T. & T. Co. on "Modern Practices in Private Wire Telegraph Service."

An interesting point brought out in the discussion of the Milnor-Randall paper, by E. R. Shute, was the reason for the demand for quick cable service. There is a demand for one minute service. Many brokers, it appears, make a living because of the slight difference in price between the same stock on two sides of the Atlantic.

In discussing the printing telegraph concentrator, Mr. Hobart Mason of the Western Union stated that the usual time involved in answering calls from customers was 3 seconds while for branch offices it was 6 seconds. This is better than average telephone practice.

Inductive Coördination

On Tuesday, in the morning, a group of papers was presented all of which were concerned with the coördination of power and telephone plant. Aside from the purely technical interest which the papers in this group exhibited, was the human aspect of the task involved. This aspect of the work was covered, first in an introductory statement by R. F. Pack, vice-president and general manager of the Northern States Power Co. and former president of the N.E.L.A., and later in a closing statement by Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Co. Previous to 1921, disputes of a very serious nature were constantly occurring between the Bell Telephone Companies and the power companies, the former claiming that the rapid construction of transmission lines by the latter was seriously interfering with telephone service. The power companies felt that they also had a duty to serve the public and resented the attempts of the Bell Companies to interfere with their growth and progress. Often these disputes brought them into court.

In 1921, however, a group of power men met with a group of Bell Telephone men and under the neutral chairmanship of Owen D. Young was formed a permanent committee which has since been known as the Joint General Committee of the National Electric Light Association and the Bell Telephone Systems. Without going into detail as regards the sub-committees formed, it may be stated here that this was the beginning of a coördinated effort to settle the mutual differences between the two groups of systems in a scientific and systematic manner, out of court. From an inductive interference committee, it developed into an inductive coördination committee, and today the coördination is no longer a problem but only a routine day to day job of coöperatively continuing research work. The whole matter is a most excellent example of intelligent human coöperative effort in solving what seemed at one time an impossible problem.

Papers presented at this session were largely statements of progress in the technical aspects of this work. There was one outlining trends in telephone and power practice as affecting coördination by W. H. Harrison of the A. T. & T. and A. E. Silver of the Electric Bond & Share Co. There were two papers dealing with research on various types of induction, and finally there was one on the coöperative work in the joint use of poles.

Circuit Breaker Theory Subject to Controversy

From an interest standpoint, the most notable session of the meeting was the one on Protective Devices on Tuesday afternoon, for it was here that the question of circuit breaker theory came up for discussion. The question of circuit breaker design has been an active one in recent years, particularly since the announcement of the Deion principle two years ago. At this session D. C. Prince and W. F. Skeats, of the General Electric Co., presented a paper describing the theory and construction of an oil blast circuit breaker. This breaker, according to the authors of the paper, owed its efficiency to the action of a scavenging blast of oil which is driven by gas pressure from an arc and which displaces the arc in the space between the electrodes of another break. The theory upon which this breaker operates was claimed by the authors to be an alternative principle as differing from the deionizing action in which the arc products are swept away by the scavenging action of an oil blast. Tests of this breaker at Philo, Ohio, referred to by the authors, showed that this breaker was materially more effective in clearing short circuits than was the ordinary oil circuit breaker with plain butt contacts. In the discussion, Dr. Slepian, of the Westinghouse Co., took violent exception to the principles discussed in this paper and criticized the authors for describing the action in a very unscientific manner. His claim was that the principle presented by the authors was incorrect and that if the breaker was as effective as the authors claimed

it to be then its action was due to the deionizing principle and not to the oil blast principle discussed in the paper. In explaining the action of the breaker, the authors endeavored to show in detail what happened within 10 micro-seconds after the contacts began to separate. This, Dr. Slepian claimed, was unimportant; what was important, he claimed, was what happened in the one or two micro-seconds after the break.

Philip Sporn also discussed this paper but his discussion did not partake of the critical attitude that Dr. Slepian's took. His discussion was largely an extension of the description of the tests at Philo and stated that the modern circuit breaker, regardless of the principle of its operation, will break as high as 1,700,000 kv-a. In the rebuttal by the authors, there was not time to answer all of Dr. Slepian's questions nor to reply to his charges. The authors stated that there might be a difference of opinion as to the principle upon which the breaker operated but the principle feature of importance at the present time was that the breaker was extremely effective.

In addition to the paper by Prince and Skeats, there were two other papers dealing with the same breakers, one by Philip Sporn and H. P. St. Clair, describing the Philo tests in detail, and another by R. M. Spurck and H. T. Strang, describing field tests.

Knowledge of Lightning Phenomena Growing

Additional data was added to the steadily growing store of information on lightning arrester action by K. B. McEachron and E. J. Wade of the General Electric Co. They described the theory of field tests on Thyrite lightning arresters using artificial lightning of 1,500,000 v.

Another paper, concerned with lightning phenomena, was one by J. J. Torok, describing an experimental lightning protector for insulators. This device operates upon the principle that excessive potentials will set up an arc in a confining chamber; the arc then is extinguished by a deionizing effect in a brief period of time thus clearing the system of a fault.

On Wednesday morning, the session was given over to a discussion of power transmission. This included papers dealing with traveling waves on transmission systems, impulse tests on substations, lightning investigations on wood pole transmission lines, lightning experiences on the 132-kv. lines of the American Gas and Electric Co., and finally, one on the attenuation and reflections of traveling waves. An interesting fact in the discussion of these papers was that brought out by E. C. Williams of the Public Service Co. of Northern Illinois, in regard to the effectiveness of wood pole lines. He stated that his company had had a number of flashovers on their 40-ft. wood poles without a single case of 60 cycle follow-up. The Public Service Co. of Northern Illinois, he said, had in service some 90 mi. of wood pole line and for voltages up to 56 kv. the results have been very gratifying. Another angle not ordinarily thought of in connection with lightning consideration, was contributed by F. W. Peek and was to the effect that we now had evidence of cases of natural lightning which approached the voltages produced in the laboratory.

A session on Industrial Power Applications, held on Thursday morning, January 29, was of interest to those concerned with the operation and design of industrial plants. While there was not quite as much interest in this session as there should have been, the fact that it was in the program was encouraging for it is a step in the proper direction. The generation of current with which most of the meetings are concerned is only one side of the picture. There are quite as many problems in the use and application of this power after it reaches its destination as there are in its generation. There were five papers submitted at this session, ranging all the way from the use of electron tubes in industry to the design and application of synchronous motors to meet special requirements.

One paper on Automatic Regulators in Industries was of great interest. Automatic regulators are well known in generating stations but their use in the industries has been somewhat limited until within recent years. Today there are available a number of different regulators having wide fields of application. In the discussion of this paper, R. G. Stanwick, of the Turbine Engineering Dept. of the General Electric Co., cited a case of a 4000-kw. turbine used for emergency operation only which normally was stopped and cold, but was arranged to come up to speed and carry load automatically by the opening of an oil circuit breaker. On actual test, this machine, from the time the first indication was given to the time that it was carrying full load, was thirteen seconds. The machine was up to full speed in five seconds.

In discussing the paper by W. J. McClain on Electrical Distribution Systems for Industrial Plants, G. S. Merril, of the General Electric Lamp Works, at Nela Park, called attention to the importance of maintaining proper voltages on the lighting systems in factories. It seems there is a wide variation of voltage in most industrial plants, ranging all the way from 68 to 135 v. In one plant which he cited, a plant using 115-v. lamps, the minimum voltage was 68 and the maximum 93. Another incident which he cited which provoked considerable amusement among the members of the audience, was that tests made the day before in the Engineering Societies Building indicated that lamps made for 120 v. were being operated on circuits of 113 v. The light loss in this case was 20 per cent and it involved a socket loss of some $2 a year.

Thursday afternoon was given up to two simultaneous sessions, one dealing with papers on electric welding and the other on electric transportation. The latter included papers on the Lackawanna Suburban electrification and on the design of the overhead system for the Cleveland Union Terminal.

The transverse Fisher detector car, developed by the late Elmer Sperry, was described by Harcourt C. Drake.

Session on Research

As usual, the session on Research was well attended and included papers of a wide variety of interest. The session on Research at the winter meeting would never be complete without a contribution by Professor Whitehead of Johns Hopkins University, and at this meeting he presented the second part of his study on the Conductivity of Insulating Oils. For many years, Dr. Whitehead and his associates at Johns-Hopkins have done notable work in the investigation of the funda-

mental properties of insulating materials and his present contribution is a valuable addition to the great mass of material which is already available.

A paper on the Control of Traffic by Light Beams excited considerable interest. This was presented by R. C. Hitchcock of the Westinghouse Co. and described two experimental installations now in operation in Wilkinsburg, Pa. The object of this traffic controller is to keep the signal green on the major streets and to give the green signal to the minor street only when requested. The minor street vehicle can always get the green signal after a short wait while the major street receives green light for as much extra time as the minor street permits.

Two papers at this session dealt with problems of current collection on alternators. In one of these papers it was brought out that brushes operating in an atmosphere of hydrogen are subject to considerably decreased life. This life can, however, be lengthened somewhat by certain conditions of operation and these conditions were discussed. It was pointed out that the success of hydrogen cooled synchronous equipment depends largely upon the solution of the brush problem.

The convention was concluded on Friday afternoon with a series of papers on Electrical Machinery. This session included papers on mercury arc rectifier research, motor design, effective transient voltages on transformer design and heat losses in turbine generators.

Always an important part of the Mid-winter Convention is the presentation of the Edison medal. This year the medal was awarded to Dr. Frank Conrad of the Westinghouse Electric and Mfg. Co. for his contribution to the development of radio. The presentation of the medal was made by William S. Lee, president of the A.I.E.E., and was preceded by an address by Professor C. F. Scott, in which he enumerated the achievements of Dr. Conrad. The presentation of the Edison medal was followed by a lecture and demonstration by Karl Taylor Compton, president of the Massachusetts Institute of Technology, on the subject of the Electron. Dr. Compton began with a historical discussion of the electron and illustrated the high spots in the development of the electronic theory by a number of interesting and sometimes beautiful experiments.

Other features of the week's program included inspection trips to many points of interest in and around New York City and, of course, the usual social and entertainment features. The inspection trip which proved most popular was one to the new Empire State Building, during which some two hundred members were given the privilege of ascending to the top of the world's tallest building. This inspection trip was of interest not only because of the immense height of the building but also because of the unusual electrical system which it contains. As is growing to be the custom in buildings of this type, vertical alternating current networks are used. The 13,800-v. cables are brought directly to transformer substations on the basement, 41st and 84th floors. From these substations a low voltage network extends to all the intermediate floors in the building. This design reduces tremendously the investment in copper required and also makes for greater simplicity of design.

High Temperature Metals for the Power Plant

Factors Affecting Creep, Strength, Ductility, Fatigue and Other Characteristics of Metal at High Temperatures in Boilers, Piping, Valves and Turbines. By H. W. Spring*

EQUIPMENT to be covered from the high temperature standpoint, of course, is the boiler, the steam headers, piping, valves, fittings, turbine, etc. Accessories, naturally, have to be taken care of, but they ordinarily do not get steam at such temperatures or pressures.

As stated, ultimate pressures of 2500 and even 3500 lb. per sq. in. are asked for. Pressures up to and including 1500 lb. per sq. in. may be said to have become quite well established; however, pressure is not the serious matter that it might seem to be, since from the engineering standpoint, one needs only to increase strength in his design as he increases his pressure. This is arrived at through the use either of a stronger material or by increasing the thickness.

Not only does a steel with a tensile strength of 70,000 lb. per sq. in. at ordinary temperature give only 35,000 lb. per sq. in. when tested at 1000 deg. F., but during the past ten years it further has become known that steels under continued stress and temperature, as, of course, occurs in pipe lines of a modern plant, has a considerably lower relation of long time or available strength to the original tensile strength at room temperature than was shown in the former short time method of testing. This latest method of testing, known as the "flow" or "creep" testing method, has gotten us pretty close to the actual truth as to the pressures and temperatures which metals will stand in continued service. Reports in considerable abundance on both the short-time and the long-time systems of testing have been published during late years, and most of you know of the existence of the Joint Research Committee of the A.S.M.E. and A.S.T.M. on The Effect of Temperature Upon Metals.

The "Flow" or "Creep" Situation

Tests show that above the strain hardening or so-called equi-cohesive temperature there is no such thing as "creep limit," creep constantly going on at some rate or other, more rapidly with higher temperatures and more rapidly with increased stress. The rate may be so slow that it will take many thousands of years to give a perceptible elongation, and at temperatures below the strain hardening limit, stretch or elongation of the steel, this constituting "cold" work, necessitates a greater stress or load to keep the steel deforming.

Another interesting thing is that even at favorable temperatures for creep, large grain-sized material has

*Crane Co., Chicago, Ill. Abstract of a paper delivered Feb. 11, 1931, before the Fifth Midwest Power Engineering Conference, Chicago, Ill., at luncheon under auspices of American Institute of Mining & Metallurgical Engineers.

greater resistance to creep than the same material with reduced grain size, whether such reduction in size is caused by mechanical working, such as rolling, forging, etc., or by heat-treatment, annealing, tempering.

Strength Versus Excess Ductility

Naturally, the engineer cannot get 100 per cent in all characteristics on the same job. It long has been known that, with any steel, the higher the tensile strength and elastic limit, the lower the accompanying elongation and reduction of area, i.e. the ductility.

Creep Characteristics of Cast Steel Versus Rolled or Forged Steel

With reference to effect of grain size in the matter of creep, there is a sort of corollary. Since larger grain sized steel is more resistant to creep than steel of small grain size, and since working a metal in forging or rolling reduces the grain size, then castings, which of course are neither forged or hot worked, should be more creep resistant than forged or rolled steel of the same composition. Our own tests reported two years ago show this to be a fact. Castings are stiffer than forgings at high temperatures and also at low temperatures.

Not only is this so at creep-encouraging temperatures, but also at ordinary or, at least, considerably lower temperatures. The conclusion must be that the forged steel with its smaller grain and higher ductility is not as stiff as cast steel. While the temperatures are not high enough to bring it into the "flow" classification, it appears that, whether cold or at the higher temperatures, the finer grain and a grain of a metal which has been worked as in rolling or forging so that the resistance to deformation of the original grains has been broken down, deform more readily, that is, at lower stresses.

A Rational Engineering View of "Flow" or "Creep"

Until recent times the engineer considered steel generally as having a tensile strength of 60,000 lb. per sq. in. with yield point of 30,000 lb. per sq. in. or more. Later, from short-time high-temperature tests, he realized that the 1000 deg. F. (540 deg. C.), say, the tensile strength is only approximately one-half; i.e. 30,000 lb. per sq. in. and the yield point 15,000 lb. per sq. in. Now that it is admitted that at that same 1000 deg. F. (540 deg. C.), steel will "flow" or "creep" under a stress of only 3000 lb. per sq. in., he naturally is troubled.

The facts are that the stretch or elongation at stresses above the elastic limit and the very slow flow which occurs at much lower stresses over a long time, are far different. From short-time high-temperature tests, it will be noted that at 1000 deg. F. (540 deg. C.), the tensile strength and yield point are approximately 30,000 and 15,000 lb. per sq. in., respectively. The flow-producing stress of 3000 lb. per sq. in. reported on this material as giving 0.0000005 in. per inch per hour flow (1 per cent in two years) brings about an extremely slow distortion, which, so far as bringing about any early rupture of the material is concerned, is practically negligible. To bring about rupture in a short period of time, the stress would have to be increased to somewhere near the short-time yield point, where the steel under observation would start visibly to elongate; but it would require stresses near to the short-time tensile strength to bring about rupture within any comparatively short time.

As shown in the figures obtained through careful tests in long-time testing equipment, a certain amount of flow is produced even with rather low loads, and in a general way, the rate of flow is proportional to the amount of load. A rate of flow of 0.000001 in. per hour per inch of length of specimen is equivalent approximately to 0.01 in. per inch per year, or 1 per cent stretch. This can be, and we believe should be, considered largely as distortion. There is no danger of rupture for a long period of time unless for some reason flow is seriously localized through overheating at some point where it is not detected, as, for example, in a boiler or superheater-tube.

Of course, these tests here given are of much shorter duration than the time required of similar materials in service. The table given indicates that little or no deterioration has occurred during the period of testing

TABLE SHOWING SHORT-TIME TESTS ON CAST STEEL SPECIMENS PREVIOUSLY TESTED IN FLOW

Material	Flow Test History					Subsequent Short-Time Tests					
	Temperature, Long-Time Test		Time under Tests, hours	Time of Testing Loads, hours	Total Flow, in. per inch	Temperature, Short-Time Test		Tensile Strength, lb. per sq. in.	Yield Point, lb. per sq. in.	Proportional Limit, lb. per sq. in.	Elongation in 2 in., per cent	Reduction of Area, per cent
	deg. Fahr.	deg. Cent.				deg. Fahr.	deg. Cent.					
0.33 per cent Carbon Steel	750	400	1008	30,000	0.0400	70	20	82,900	53,800	51,800	21.0	34.0
	1000	540	1008	4,000	0.00216	70	20	80,450	43,000	39,000	27.5	41.5
	....	...	none	.....	none	70	20	83,050	43,500	39,500	25.0	38.5
0.40 per cent Carbon Steel	900	480	504	4,000	0.00045	70	20	82,400	42,000	41,000	23.5	36.2
	....	...	none	.....	none	70	20	81,100	37,800	36,000	24.0	34.7
0.40 per cent Carbon Steel	550	290	456	12,000	0.00031	550	290	74,700	29,300	21,500	23.5	27.0
	...	..	none	.....	none	550	290	80,000	30,000	19,000	17.0	25.0
0.23 per cent Carbon Steel	750	400	1100	30,000	0.0160	750	400	67,500	39,400	29,500	27.5	42.4
	..	...	none	.....	none	750	400	63,000	29,000	18,000	29.0	50.0
0.33 per cent Carbon Steel	750	400	1672	15,000	0.00090	750	400	72,900	28,500	18,000	28.0	42.7
	...	..	none	.....	none	750	400	69,000	27,500	17,000	31.0	53.0
0.40 per cent Carbon Steel	900	480	504	5,000	0.00047	900	480	54,600	23,700	14,000	33.5	55.4
	....	..	none	..	none	900	480	58,000	25,000	10,000	32.0	59.0
0.33 per cent Carbon Steel	1000	540	1008	3,000	0.00130	1000	540	45,100	21,000	9,000	34.0	54.1
	....	...	none	.....	none	1000	540	45,000	20,000	8,000	33.5	59.0

since test specimens which had been subjected to a period of temperature and flow gave practically the same tensile properties as duplicate specimens, which had had no previous testing. Deterioration should not be expected, unless through oxidation, which can be fairly well prevented.

Fatigue of Metals

Apparently, at temperatures of 750 deg. F. or over, i.e., temperatures of operation of the modern steam plant, fatigue has lost most of its importance as a factor. Therefore it generally is considered that fatigue and creep factors are opposites and that one decreases as the other assumes importance.

Corrosion

In addition, the question of corrosion, embrittlement, or other corroding condition must be looked out for. Naturally, metals must be used which are not eaten away, which in effect would be to reduce the metal thickness, and therefore the strength of the structure.

Boiler Shell, Piping and Pressure Containers

Boiler shell, headers, piping and, to a certain extent, valve bodies, are parts of the equipment which can be allowed to breathe or weave about somewhat and in general they quite easily can be built with sufficiently thick wall to give strength for the purpose designed. On the other hand, the interior or working parts of the valve, consisting of the seating arrangements which have to fit

tightly to close the valve satisfactorily, and parts of the steam turbines which use the steam, have to have and maintain for the period of operation particularly nice fit and adjustment.

The boiler shell, headers and the piping are made of carbon steel, these carrying steam at temperatures not higher than the specified 850 to 1000 deg. F. With the still higher pressures which are contemplated and the full 1000 deg. F. steam, metals of better physical properties than carbon steel are being considered.

New and More Serviceable Materials

New steels are evaluated in prospective way by their higher physical properties cold and in the laboratory at higher temperatures up to 1600 or 1800 deg. F., or more. Their coefficients of expansion, resistance to oxidation and corrosion, their availability, workability or ease of preparation, reasonable cost, etc., also have to be considered.

Valves

Closure of a valve must be perfect if steam, gas or other fluid is to be prevented from leaking through the valve.

The seating metal chosen, therefore, and its accurate manufacture and fit in the valve, is a most important matter since the tightness of seat may be considered the lift of the valve. Brass, monel metal, nickel, nickel alloys, stainless steels, and some harder alloys, are used —depending upon the service desired. The corrosive influences spoken of before, the hardness, coefficient of expansion and several other qualities, must be taken into consideration in selecting metal for service in seats.

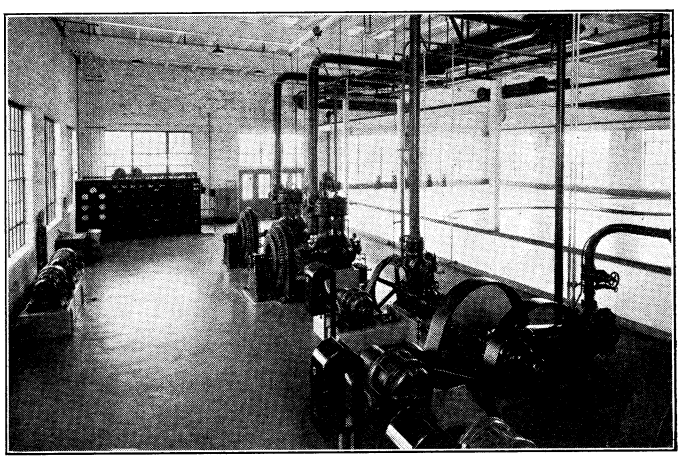
In general, seats of cast materials seize and tear each other less than forged or rolled metals; metals of high hardness less than those of low hardness; metals of somewhat different hardness less than those of approximately equivalent hardness and dissimilar metals probably less than seats of like metals. These considerations are explained mostly on the theory that the same metals have the same type and ordinarily much the same size of grain, thus giving rubbing surfaces with like projections and interstices which facilitate grabbing or interlocking of crystals.

Nitralloy—A New Seating Metal

How much of a factor in resisting seizing and scoring, "hardness" of the material is, is not definitely known; though, other things being equal, hardness is quite a factor. The extremely hard, case-hardened carbon steel with 700 Brinell makes a good seating metal so far as this one matter of "seizing" or tearing is concerned, but it is not non-corrosive, and a valve seat which rusts under ordinary conditions of moisture, of course, is impractical. A comparatively new seating metal, Nitralloy, has appeared. Nitralloy is a forgeable steel containing small proportions of chemical elements which cause the surface of the alloy to become glass hard when heated to 900 or 1000 deg. F. for a period of hours in a stream of dry ammonia gas. This case or coating, which usually is from ten thousandths to thirty thousandths inches thick, depending upon the length of "nitriding" treatment, is non-corrosive under ordinary circumstances, does not seize or tear and has the peculiar and happy advantage of becoming smoother as it wears. Nitralloy is giving quite satisfactory results in steam service.

Modern Ice Plant in Kansas City

IN THE ACCOMPANYING photograph is shown an unusually good picture of a modern ice plant, showing not only the machinery, motors, control, etc., but also the freezing tanks. This plant, which is that of the City Ice Co. at Kansas City, Mo., reflects modern development in refrigerating engineering to a high degree. A striking feature is its cleanliness and roomy atmosphere. An abundance of daylight illuminates every nook and corner of the plant, making inspection convenient, thus contributing to the upkeep of the plant. Cleanliness in a plant is an important factor; it pays to keep a plant in clean, orderly condition. A corner filled with filth



VIEW IN THE PLANT OF THE CITY ICE CO., KANSAS CITY, MO.

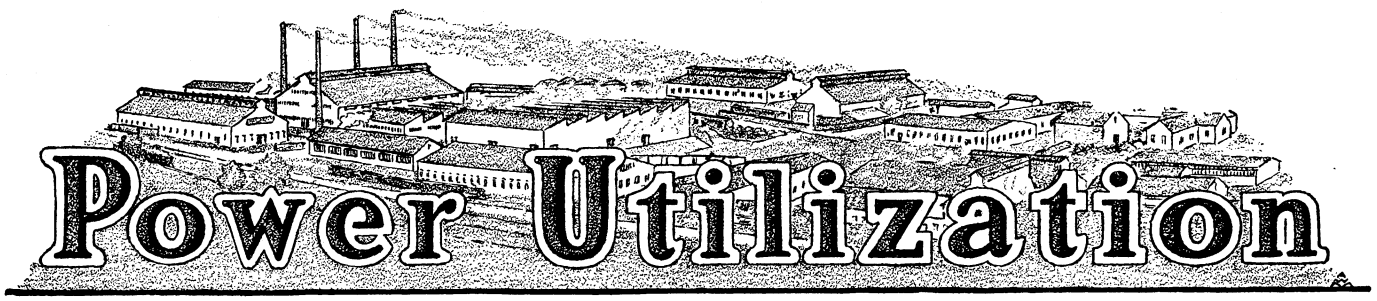
and trash invites and receives more of the same. Greasy and ill-kept floors will get into such chronic state of deterioration that everyone who comes along will take pleasure in adding to the general muss. There is very little chance for dirt accumulating in the plant shown here.

In the center are the two main York ammonia compressors driven by 75-hp. synchronous motors and a smaller ammonia compressor used as a spare unit and driven by a 25-hp. induction motor. In the immediate foreground are two Pennsylvania air compressors driven by 40-hp. induction motors. At the left along the wall are two 16-kw. motor-generator sets for exciting the synchronous motors and the control switchboard is in the background.

The switchboard and all driving motors were furnished by the General Electric Co.

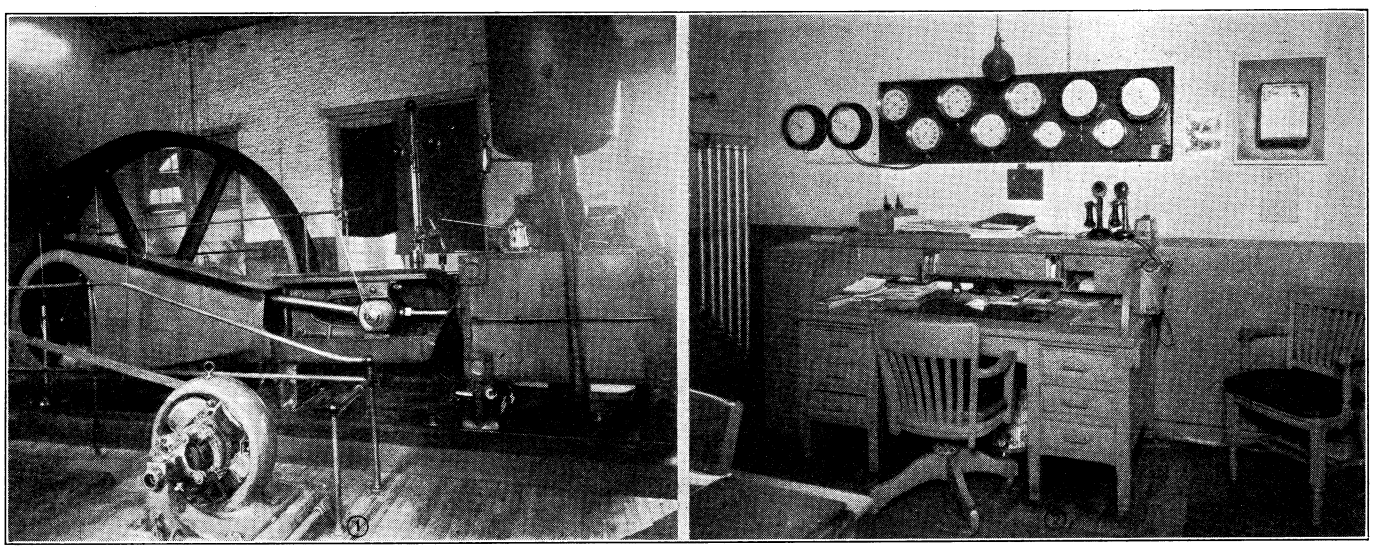
Greatest strength of leather is found in the flesh side. Splitting leather into three layers, laboratory tests have shown that 17 per cent is in the grain split, 33 per cent in the center split and 50 per cent in the flesh split. As the grain side gives better grip on the pulley and the outer side of the belt takes more stress and bending, practice of running the grain side next the pulley gives best durability.

Many engineers will pay a much higher price for a piece of equipment because its efficiency is a per cent or two above the next and then let it run at low efficiency through lax operating methods. You can buy efficient machines but they won't operate themselves.



Power Saved in Industrial Plant by Remodeling for Motor Drive and Centralized Control Operation

By L. A. Corwin



THE OLD AND—
42-YR. OLD CORLISS DROVE SHAFTS AND BELTING

THE NEW
METERS AND SIGNALS GIVE CENTRALIZED CONTROL

TODAY many plants are considering the problem of most economical power distribution, utilizing equipment already on hand. Much production machinery is in such good condition that the investment for replacement is unwarranted, yet it is desirable to put the drive on a more efficient basis. Present business conditions demand greater efficiency, higher speed and such changes as will produce those results.

How Much Power?

In our plant, after long use of a girder type Corliss engine, with 290-ft. line shaft, counter shafts and belt drives, a complete change was required. As a first step, a field survey was made, taking the indicated power of the engine when running idle, when driving the line shaft, the line plus counter shafts, various machines idle and when working. In this way, friction load and useful power were determined, also the engine power used by each machine when belt driven.

With this survey completed, the next step was to determine the size motor to be used for each machine and how best to connect the motor.

Motor Equipment

In many instances, the machines were of old type, unsuited for direct drive, yet new machines would not reduce labor of operation or increase output. Some were speeded up as much as 20 per cent. Some were direct connected, others fitted with Texrope drives; those which were obsolete were replaced. All were equipped with push-button control located for convenience of the operator to avoid lost time in starting and stopping.

No fixed rule was followed as to make of motor, equipment being chosen to fit the particular requirements of each machine. Standard motors were used, but selected according to performance as guaranteed by the maker, taking account of starting and running torque, current, regulation and other characteristics.

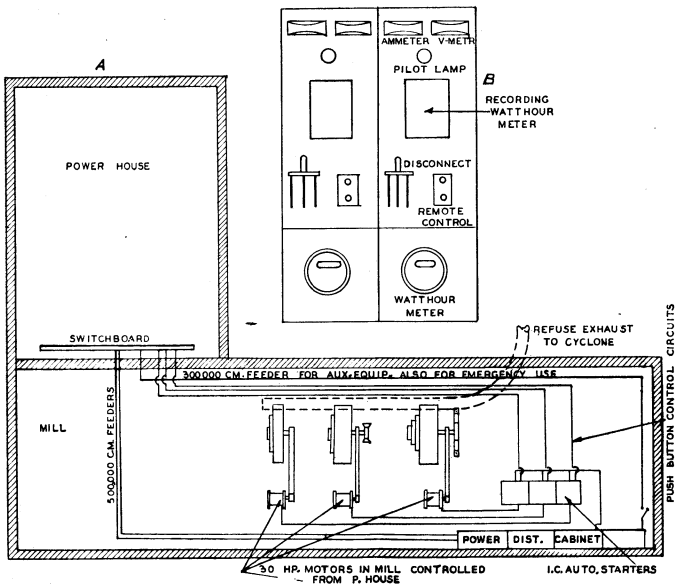


FIG. 3. A. FAN MOTOR AND POWER SUPPLY. B. FAN AND FREQUENCY CHANGER CONTROL PANELS

All motors had ball or roller bearings so that they could be placed in any operating position without regard to lubrication requirements, also with a view to reduced friction load.

Motor starting equipment was standardized, the I—C type being selected, for ease of access in making repairs and convenience in carrying spare parts.

Motors were figured at 5 to 7 per cent overload, even with heavy starting torque, so as to get good loading on average running. As a result, a power factor of 83 per cent for the system was attained without the use of static condensers or synchronous motors for power factor correction.

Operation Control

Installation of distributing cabinets, Fig. 3A, was an important detail in feeder service. Feeders were so run that in case of breakdown of any one, some other could be used as an auxiliary thus giving continuous service.

As far as possible, all electrical equipment was under full automatic control. Sturtevant fans in the main heating system were rebuilt from engine drive for motor drive and put under automatic and temperature control of a Mercoid unit. For the rest of the heating system the heating units were also put under Mercoid control and outlying coils were regulated by thermostats.

Where old production machines were considered not worth revamping for motor drive, new equipment was purchased with drive of the 7200-r.p.m. type. This required frequency of 120, so a frequency changer, 60 to 120, was installed in the power plant, for supervision, the operation being controlled by a man in the factory who operates the high-frequency-driven machines so that the frequency changer will run only when needed. There is an emergency disconnect switch in the power plant for use in case of emergency or trouble with the frequency changer. The controls for heating fans and frequency changer are shown in Fig. 3B.

Current to various departments is metered to determine cost of power for production processes. Recording watt-hour meters and gages are installed in the chief engineer's office so that, as load varies, he or his assistants may govern steam pressures and generator operation to meet conditions. Electric signals to colored lamps are transmitted to boiler and turbine room operators, no audible signals being used, as operators are required to be working at their stations to maintain highest possible efficiency.

Complete outfit of instruments gives a picture of the power and heat use at all points in the plant so that centralized control from this office is attained.

Motor Care

Cleaning of motors is given great care, due to dust conditions in a woodworking plant and the fact that motors are not totally enclosed. Air lines are installed to serve motors within a given area by means of a short length of hose, making it easy to clean motors frequently. Each day, all of the 168 motors, ranging from ½ up to 40 hp., are given a cleaning.

For exhaust fan equipment, handling dust and

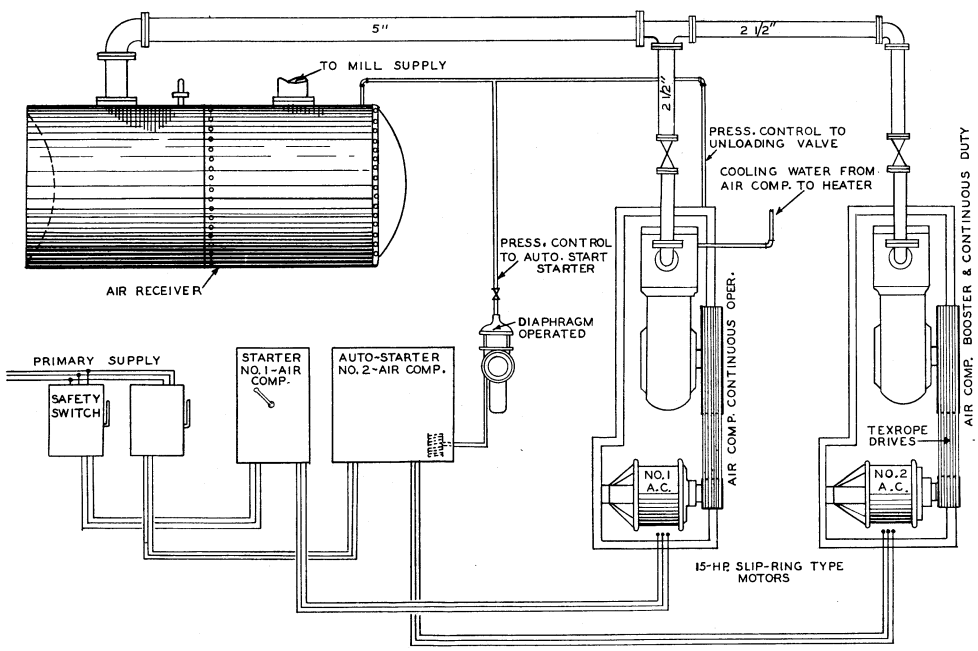


FIG. 4. AIR COMPRESSOR ARRANGEMENT AND CONTROLS FOR UNLOADING AND AUTOMATIC STARTING OF BOOSTER UNIT

refuse, across-the-line starters are used, of 30 hp. capacity, starting and stopping being by remote control from the power plant, with signal pilot lights to assure the operator of proper working. Primarily, this was done to acquire immediate load at starting periods for synchronizing generators and to give complete early relief of load when closing down.

Unquestionably, the engineer usually finds production of compressed air expensive. Often equipment is bought too large with a view to future needs, or requirements may be underestimated so that compressors are overloaded all the time with resultant high upkeep costs.

For this plant, the problem was solved by purchasing two compressors of identical rating, Figs. 4 and 5, each being for 90 c.f.m. and driven by a 15-hp. slip ring motor. The No. 2 unit is under manual control with unloader and runs continuously. Number 1 is full automatic. It starts when pressure in the receiver falls to 5 lb. below normal, raises pressure back to normal and runs so long as demand is greater than the capacity of No. 2 unit. When no longer needed, it shuts down. This gives a spare machine to fall back on in case of accident to either one, so that shut down of one or several departments can be avoided, even though full normal pressure is not maintained.

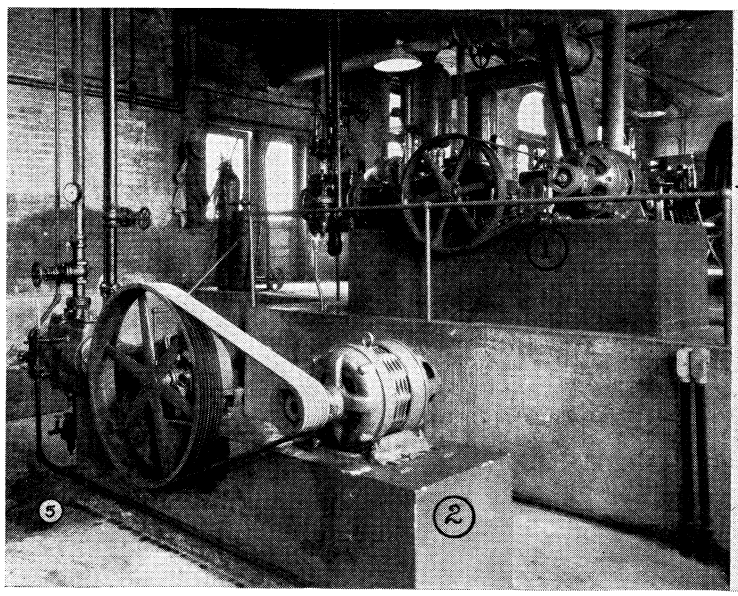
This equipment cost is less than for a single machine and drive of the same total capacity which would lack the flexibility and reliability of the present system. Air is furnished on 24-hr. service by the combination equipment. It has operated without failure for over 3 yr.

Entire change over to electrical equipment and motor drive was made without shutting down any machine during working hours. First of all, cabinets and main feeders were installed, then distribution lines to motor positions and starting equipment. Meantime the new generating plant was finished so that electric power was available. Whenever a machine was out of work for a time, its motor was set, wired up and connected for driving. Machines which could not be so handled were motorized in overtime after factory working hours.

As a result of the changes, friction load of 43 per cent has been turned into available power. Economy of the new steam plant resulted in further gain in steam consumption and cost of operation, so that a total saving of 60 per cent was made.

Indicative of savings made, a 2-hp. motor drove a heavy band saw which before had a 7-hp. belt drive. Figure 6 is a 3-phase motor drive for a heavy duty sander, 10-hp. at 220 v. and 60 cycles, replacing a 17-hp. belt equipment. Drive for a double-knife planer is shown in Fig. 7, a 15-hp. motor in place of the former 32-hp. belt drive.

This again proves that it pays to overhaul and remodel and to take advantage of the improvements provided by makers of engineering equipment.



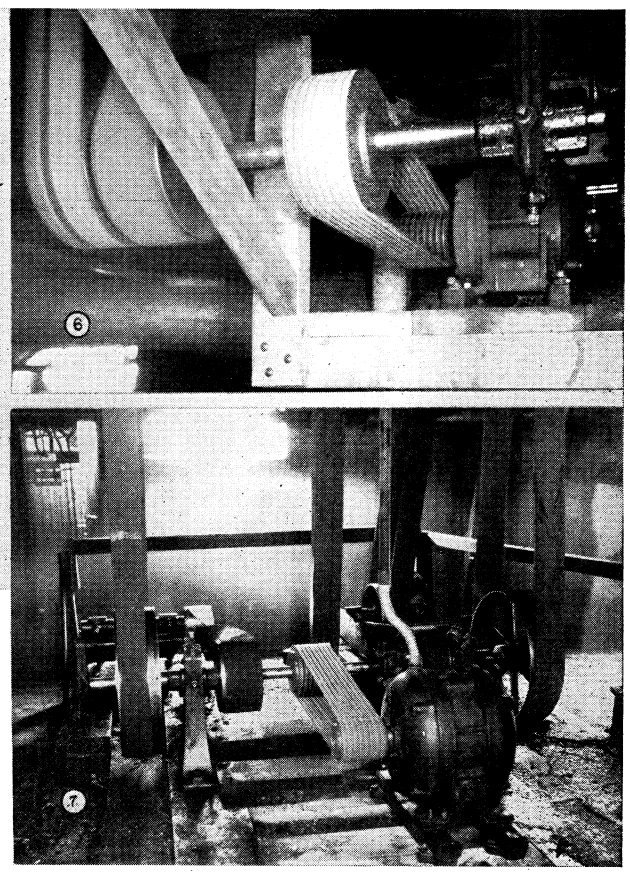


FIG. 5. DUPLICATE AIR COMPRESSORS

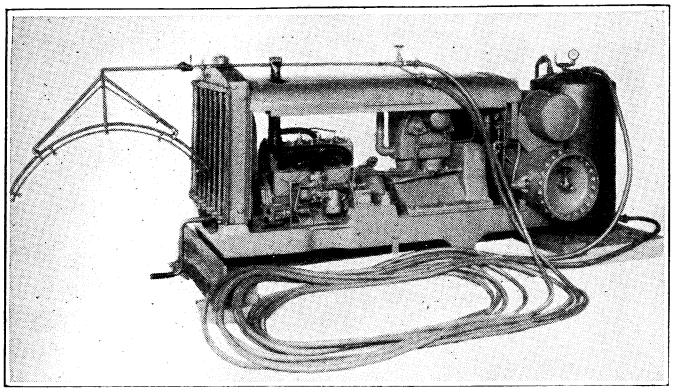
FIG. 6. 10-HP. MOTOR FOR SANDER DRIVE

FIG. 7. 15-HP. DRIVE FOR DOUBLE PLANER

Compressed Air in the Industrial Plant

USE OF compressed air in spraying operations finds application in many industrial processes. Instead of mixing color with cement or painting the cement after it has hardened, it is now being colored by dampening it with a stream of water, then blowing thereon with a suitable spray gun a cement-like powder of any desired color. The powder combines with the water and adheres to the rough surface forming a permanent coating that is also waterproof.

Material for heat insulating or sound proofing buildings is now being applied with a special spray gun.



PORTABLE APPARATUS FOR PAINT SPRAYING

In this process, bits of water paper and cloth of the size of confetti mixed with a solution of silicate of soda or water glass, which is a syrupy fluid forming the binder, after being sprayed on a surface and becoming dry forms a hard, permanent glass-like surface. Air for feeding the loose flakes to the gun is supplied by a small blower while a compressor furnishes the air for introducing the liquid binder and for syraying the mixture on the surfaces to be treated. The thousands of air cells contained in the fibrous mass cause it to possess excellent insulating and sound proofing properties.

Compressed air is now used to clean and lubricate ducts for the reception of electric cables. A high-pressure soapstone gun will thus prepare conduits having an average length of 400 ft., forcing through them about 15 lb. of material for each 100 ft. of duct in 10 min. Spraying of atomized metal upon other metals and materials is also done by compressed-air guns. Concrete can be thus coated with molten tin, zinc or lead, while such metals as aluminum can be applied in the form of a spray to other metals.

Painting in industrial processes is now being accomplished by means of spray guns. Formerly oil and gas pipelines were given protective paint applications by manual use of brushes. Work of this kind formerly performed by from 30 to 35 men is now done in the same time, with the aid of compressed air and the apparatus shown above, by nine men and a considerable saving is secured in the amount of paint used. The apparatus is carried on skids so that the entire rig may be easily mounted on the contractor's motor truck.

Protective Grounding of Electrical Systems

By O. H. Henschel

Accepted codes specify that ground conductors shall be of copper or other non-corroding metal, if practicable without joint or splice, and shall carry no automatic cutout except in a connection from equipment where its operation will result in the automatic disconnection from all sources of energy of the circuit leads connected to equipment so grounded.

In the case of three-wire, direct-current distribution systems, the ground connection shall be made on the neutral at one or more supply stations but not at individual services or within buildings served. In two-wire systems, the ground connection shall be made on one-wire at one station only.

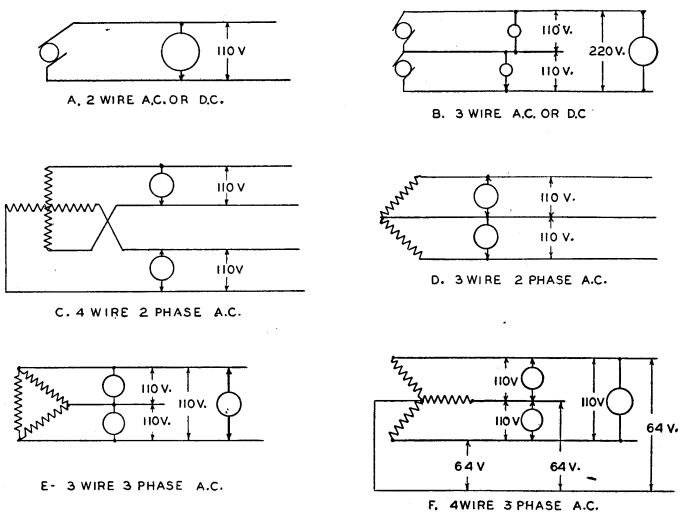
Alternating-current distribution system ground connections shall be made at the building service or near the transformer or transformers, either by direct ground connection through water piping system or artificial ground or by the use of a general system ground wire.

In single-phase, three-wire systems, B, the ground connection shall be on the neutral conductor and in single-phase, two-wire systems, A, on the neutral point or on either conductor.

Where three-phase, three-wire, delta-connected systems, E, are employed, the ground connection shall be made on one phase conductor or on the neutral point of one phase. Such ground connection should be made, however, to that point of the system which will enable making connection to water pipe rather than to an artificial ground.

In three-phase, three or four-wire systems, star connected, F, the ground connection shall be made at the point common to all phases.

The ground conductor, or conductors, shall have a combined current carrying capacity sufficient to insure



SYSTEMS OF CONNECTION FOR DISTRIBUTION

the continued effectiveness of the ground connection under conditions of excess current, caused by accidental grounding of any normally ungrounded conductor of the circuit. No individual ground conductor for electrical circuits shall have current carrying capacity less than that of a No. 6 copper wire, except that for additional grounds after the first ground on any circuit, smaller ground wires may be employed, provided they have a conductance equal to that of No. 10 copper wire.

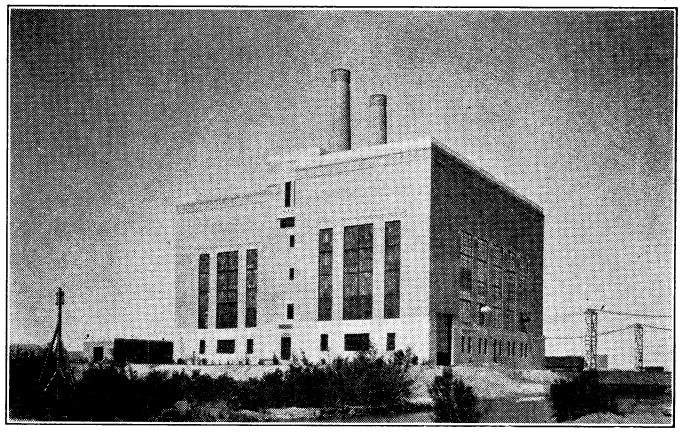
Ground conductors for a three-wire, direct-current system, B, shall have a combined current carrying capacity not smaller than the neutral conductor to which they are attached, except that the capacity need be no greater than that of the largest feeder of the same system.

For alternating-current systems, the ground conductors shall have a combined current-carrying capacity not less than one fifth that of the conductor to which they are attached, except that they need have a conductance no greater than that of No. 0 copper wire.

Ground wires for conduit shall have a conductance at least equivalent to No. 10 copper wire, where the largest wire contained is No. 0 copper wire, or less. A ground wire of a conductance at least equivalent to a No. 4 copper wire shall be used where the largest wire contained is larger than No. 0 copper wire.

Rio Grande Station Burns Natural Gas

NEW POWER PLANT OF THE EL PASO ELECTRIC CO. HAS GENERATING CAPACITY OF 43,750 KW. IN TWO UNITS AND TWO 1525-HP., 450 LB., 750 DEG. STIRLING BOILERS



EXTERIOR VIEW OF NEW RIO GRANDE STATION

NATURAL GAS from New Mexico will be used for fuel in the new Rio Grande station of the El Paso Electric Co. located on the Rio Grande River about 4 miles upstream from the old station. Total generating capacity of the new station consists of one new 25,000-kw. turbo-generator and one 18,750-kw. unit moved from the old plant, giving a total capacity of 43,750-kw. Both generators have direct connected exciters and the turbines exhaust respectively to 24,750 and 25,000 sq. ft. surface condensers.

Steam is generated in two 1525-hp., 450-lb. boilers with a capacity of 184,500 lb. of steam per hour. Boilers are complete with water-cooled walls, totaling 1249 sq. ft. tubular air heater and superheaters giving a final steam temperature of 750 deg. F. Condensing cooling water is at a premium in this country and the plant is located where the main drainage canal of the irrigation system joins the river. On occasions of extremely low water, the plant is arranged so that condenser discharge will flow up stream and join the fresh water coming into the system.

Station auxiliaries are all designed for motor drive with the exception of one steam driven boiler-feed and fuel-oil pump and the spare exciter set which is dual-drive. A 2000-kw. house generator, designed to take full load in 20 sec., can be operated by a push button on the switchboard. Feedwater is heated in three stages including one high-pressure closed heater, one deaerating heater and a low-pressure closed heater while a two-unit single-effect evaporator supplies boiler feed make-up.

Boiler furnaces are equipped with combination natural gas and fuel oil burners. Forced draft for each boiler is supplied by one fan with inlet for volume control and driven by constant speed induction motor. Each boiler is also provided with a movable inlet induced draft fan direct connected to two constant speed induction motors to take care of different load conditions.

Main units generate 13,300-v., 3-phase, 60-cycle which, for transmission purposes, is stepped up to 66,000 v. through a bank of three 12,500-kv-a. single-phase transformers. The auxiliary system is normally fed through a 3-phase, 2500-kv-a. 13,800/2300-v. transformer and in emergencies by a 2300-v. house transformer. All auxiliary motors of over 50 hp. are fed direct from the 2300-v. circuits and the smaller motors from the 460-v. system which in turn is supplied by two 300-kv-a. 2300/460-v. 3 phase transformers. Full voltage starting motors are used throughout the plant. Station lighting is supplied from two 100-kv-a. single-phase transformers.

Principal Equipment in the Rio Grande Station

Engineers ..... Stone and Webster Engineering Corp.
Present capacity .....43,750 kw.
Ultimate capacity .....180,000 kw.
Location.....El Paso, Texas
Service .....Central Station

BOILER ROOM

2 Babcock & Wilcox Co. 1525-hp., 450-lb. Stirling Class XXIV boilers with a capacity of 184,500 lb. of steam per hr.
2 Babcock & Wilcox Co. inverted convection superheaters to give a total steam temperature of 750 deg.
2 Fuller Lehigh Co. water-cooled furnaces: Front wall, 240 sq. ft.; rear wall, 499 sq. ft.; both side walls, 510 sq. ft.
2 B. F. Sturtevant Co. 75,000-c.f.m., forced draft fans with inlet vane volume control, each driven by constant-speed induction motor.
2 B. F. Sturtevant Co. 130,000-c.f.m. inlet vane control induced draft fans, each fan driven by 2 constant-speed induction motors.
2 Ingersoll-Rand Co. 800-g.p.m. boiler feed pumps, one driven by a 500-hp. motor, the other by a 369-hp. non-condensing turbine.
3 Quimby Pump Co. 35-g.p.m. fuel oil pumps.
2 Whitlock Coil Pipe Co. closed type fuel oil heaters, each designed to heat 600 lb. per min. of fuel oil from 90 to 290 deg. F.
1 Pittsburgh - Des Moines Steel Co. 10,000-bbl. steel fuel oil storage tank.
2 International Filter Co. 15,820-gal. per hr. water filter.
2 Alphons Custodis Chimney Const. Co. superimposed concrete stacks, 7 ft. in dia. by 50 ft. high.
1 Leeds & Northrup Co. combustion control.

TURBINE ROOM

1 Westinghouse Elec.. & Mfg. Co. 25,-000-kw. horizontal impulse-reaction type turbine with 1 impulse stage and 28 reaction stages, driving a 25,000-kw., 13,800-v., 3-phase, 60-cycle, 80-per cent power factor generator. Maximum steam consumption, 33,000 lb. per hr. of 425 lb. 725 deg. steam.
1 General Electric Co. 18,750-kw., 7-stage horizontal impulse turbine, driving a 18,750-kw., 13,800-v., 3-phase, 60-cycle, 80-percent power factor generator.
1 Westinghouse Elec. & Mfg. Co. 2000-kw., 2300-v., non-condensing house turbine with a steam consumption of 40,000 lb. per hr. of 425 lb. 725 deg. steam.
1 200-kw. Westinghouse Elec. & Mfg. Co. dual drive exciter.
1 C. H. Wheeler Mfg. Co. 24,700-sq. ft. surface condenser.
1 Ingersoll-Rand Co. 25,000-sq. ft. surface condenser.
2 C. H. Wheeler Mfg. Co. 17,500-g.p.m. horizontal, double suction, centrifugal circulating water pumps.
2 Ingersoll - Rand Co. 15,000 - g.p.m., Cameron NFV No. 34 circulating water pumps.
2 C. H. Wheeler Mfg. Co. 275,000-lb. per hr. horizontal, single-suction centrifugal condensate pumps.
2 Ingersoll-Rand Co. 350,000-lb. per hr. horizontal, single - suction centrifugal condensate pumps.
2 C. H. Wheeler Mfg. Co. 125-lb. air per hr., 2 stage steam eductors with separate inter and after condensers.
2 Ingersoll-Rand Co. 375-lb. of air per hr., 2 stage steam eductors, consisting of twin "B" coolers with inter and after condensers.
1 General Electric Co. 40,000-c.f.m., 2 section generator air coolers.
1 Griscom-Russell Co., 56,500-c.f.m., 2 section generator air coolers.
1 Cochrane Corp. 564,600-lb. per hr. deaerating heater.
3 Foster Wheeler Corp. extraction heaters with surface of 1661, 1056 and 1075 sq. ft., respectively.
2 Foster Wheeler Corp. 11,695-lb. per hr., 2 units, single-effect evaporators.
1 Elliott Co. 12,000-lb. per hr. open evaporator feedwater heater.
1 Niles Crane Corp. 100-t. turbine room crane

Power Engineer Must Be Diplomat

AMONG OTHER THINGS, the proper functioning of an industrial enterprise depends upon the co-operation of various departments. These departments, for convenience, are usually classed as productive or non-productive, depending upon whether that particular department deals directly or indirectly with the output of the plant. Except in the case of public utilities the power plant falls into the second classification that is non-productive and as such does not always receive the consideration it deserves. This department, in fact non-productive departments as a whole, may be compared to the insulators on a high tension transmission line. The fact that they have no part in the actual transmission of energy does not detract from their importance and responsibility to the system as a whole.

Failure of the power supply in many industries means a complete tie-up of the plant and often a considerable loss from products in the process of manufacture. A failure of this kind can usually be forestalled by duplicate equipment, or by having an outside source of power available as a standby. Either is a matter of some expense, although this in a measure is responsible for the rapid growth of central stations and the abandonment of many of the smaller industrial power plants. Even industries requiring process steam sometimes find it to their advantage to depend upon an outside source for their electric energy.

During the last few years, the lead taken by the larger companies coupled with the publicity given this phase of engineering by the various engineering societies has been effective in raising the standard of the industrial plant. Improved cost accounting methods and close competition in many quarters has also been instrumental in bringing the power plant to the attention of the management. A thousand dollars off the coal bill is as effective in cost reduction as an improvement in production which would net the same amount.

As a rule, it is not easy to place the responsibility for inefficient power conditions. Conditions there are more or less an outgrowth of industrial development although the engineering profession cannot escape a certain amount of responsibility. It is but natural for executives who have been trained in the administrative and production phases of the business to keep clear of a subject so technical and focus attention upon the revenue producing departments. Often cost data is not arranged to show the power cost as a whole but is split up among various departments minimizing its importance and relation to the plant as a whole. Many times, power plants designed by experts at the time the plant was built are allowed to become obsolete even though such records as are kept may show that the operation is on a par with the original performance. Even if this be true, the performance is below the average, because the progress of industry and of power plant practice has gradually forged ahead leaving the power plant in the position of a leader in a footrace who, losing several strides, finds himself far behind the others.

It is an exception rather than the rule when the expansion of the power department keeps pace with the development of the plant as a whole. As long as service is reasonably continuous, the power department goes on with little or no supervision until like the one hoss shay it goes to pieces. The result is either a new plant, necessitating a curtailment of production until completed, or else in another company joining the ranks of central station customers.

Where central stations are available, it is often advisable to purchase power and each installation must be considered as an individual problem. The usual investigation shows the power department is not conducive to a wage which attracts engineers capable of putting the problems of the department before the management from the standpoint of economies. As power relates to the entire organization, departmental coöperation and industrial application are important and it is necessary that the engineer be a capable operator and at the same time broad enough to grasp the important details of the entire organization.

Supervision of the power department by the head of the organization is as important and as practical as any other phase of the business. Supervision of the right kind will quickly show up an incompetent man and keep the competent ones on their toes. If the size of the organization justifies a mechanical engineer, matters are easier for the operators because it is simpler to put a clear, concise power proposition before an engineer who is familiar with the work than before a business executive who is not. The mechanical engineer, on the other hand should be able to translate the technical needs for the operators into non-technical language and present it to men who are not engineers.

Steam and Water Control Equipment-Valves

CONSTRUCTION FEATURES of the Barco lubricated service and curb cock, brought out during the past year by the Barco Mfg. Co., Chicago, Ill., and described on page 138 of the January 15, 1931 issue, are shown by Fig. 1. This curb cock is provided with a threaded well at the top into which a pipe may be screwed, the pipe extending to the ground level after which the pipe

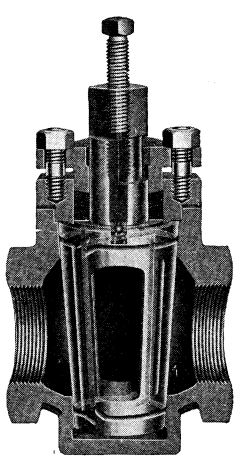


FIG. 1. BARCO MANUFACTURING CO., LUBRICATED CURB COCK

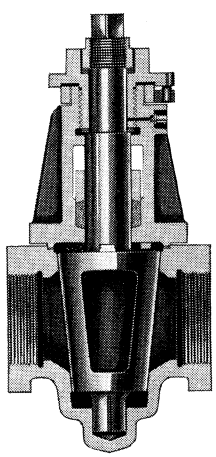
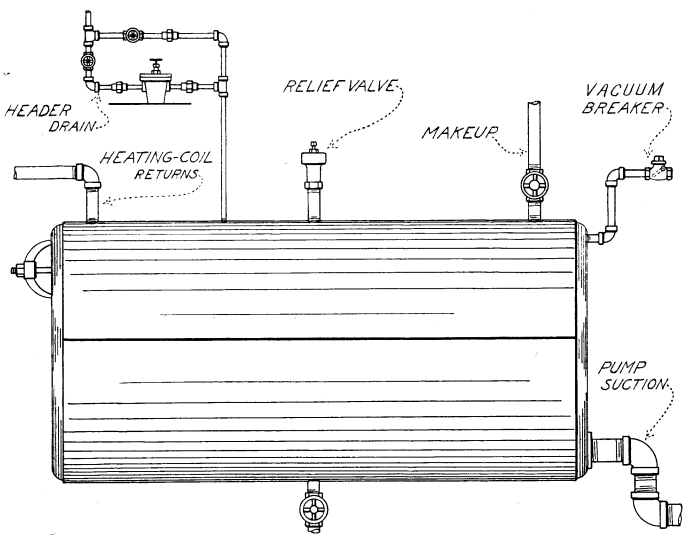


FIG. 2. MICHIGAN VALVE & FOUNDRY CO., SCREW LIFT PLUG VALVE

is capped. Figure 5, page 138, used to illustrate the Barco Mfg. Co. curb cock, should have been captioned, the Michigan Valve & Foundry Co. (Lansing, Mich.) new screw lift valve. It is reproduced above as Fig. 2. The description of this latter valve appeared on page 140 of the issue mentioned above.

Attachment of Relief Valve Removes Danger of Bursting Condensate Tank

CONDENSATE resulting from the use of live steam for heating purposes in the industrial processes of a manufacturing plant was trapped to a closed tank from which



CONDENSATE TANK EQUIPPED WITH RELIEF VALVE AND VACUUM BREAKER

the boiler feedwater was drawn. The condensate which formed in the main steam line was also trapped to this tank. Makeup water, the flow of which was controlled by an ordinary gate valve, was taken from a settling tank set at a moderately high elevation, into which water from a nearby stream was pumped.

Fifteen pounds pressure was the maximum safe pressure of this tank and, as originally installed, it lacked the relief valve and vacuum breaker shown in the illustration. Uncertain operation of the feed pump became apparent, the cold water condensing the vapor arising from the hot condensate producing a partial vacuum occasionally. To overcome this defect, the vacuum breaker consisting of a swing-check valve set to open inward, was attached.

More important, however, was the need of protection against overpressure. Through lack of proper attention the bypass around the trap in the drainage line from the main steam header was left wide open, causing an excessive pressure to be built up in the tank, which resulted in ripping the tank open for about two feet along the longitudinal seam. Patching the old tank restored it to usefulness and attaching the relief valve, which was set to open at about 8 lb., prevented repetition of the mishap.

St. Louis, Mo. A. J. DIXON.

Inside Calking Protects Boilers Against Caustic Attack

EXCEPTION HAS been taken to the statement on page 1402 of the Dec. 15 issue, "It is found that if inside calking is not properly done attack may even be accelerated," because it is inferred that such acceleration has been accomplished instead of being possible, which was intended.

Dr. R. E. Hall states that since no data is presented which shows caustic attack under conditions of improper inside calking and since we know of no such data, positive assurance of such action would convey the wrong impression. No actual examples of such caustic action were presented by the Southern California Edison Co. from whom the original statement regarding inside calking was received.

On the other hand, Dr. Hall believes that positive proof is established that inside calking alone protects against such attack because, even if improperly done and leakage occurs, a passage will be left clear out to the outside of the drum and no entrapment will occur. In substantiation of this proof attention is called to statements made on page 11 of the N.E.L.A. Publication No. 051, June, 1930, which are abstracted below.

"It is believed that inside calking automatically provides protection because of the manner in which evaporation occurs in the seams under these conditions. The reasoning leading to this conclusion has been developed in part through consideration of what happens to a dilute solution containing caustic or caustic and sodium carbonate when subjected to evaporation.

"As evaporation of the dilute solution proceeds and concentration occurs, the temperature necessary to cause boiling at normal pressure increases. If surrounded by steam at 15 lb. per sq. in. pressure or more, further concentration will not occur unless the temperature is raised. In case sodium carbonate has been present, its concentration in solution would have been decreased to at least three per cent, since its solubility is largely diminished in the presence of the caustic. If, however, the water vapor resulting from evaporation of the

caustic solution is dissipated, evaporation occurs against slight back-pressure of water vapor.

"With outside calking or inside and outside calking, the slow dissipation of steam pressure in the seam will result in continuously maintaining the caustic solution therein at a highly corrosive concentration.

"With inside calking only, relatively rapid dissipation of any water vapor pressure and contact of the solution concentrating in the seam with the carbon dioxide of the flue or other gases minimize possibility of contact between the metal and the highly corrosive solution. The absorption of carbon dioxide, attended by instant precipitation as solid sodium carbonate and by decrease in concentration of caustic, is probably the major protective factor since the sodium carbonate so precipitated exercises the same protective function as sodium sulphate.

"On the basis of this analysis, it seems that inside calking plays a positive protective role in addition to any other advantages it may offer. This conception seems in accord with the results of operating experience."

Efforts of certain boiler makers to provide protection to a boiler by means of inside calking were rendered totally ineffective, in a case related by Dr. Hall, in which a boiler which just had been erected and carefully calked on the inside only at the factory, was found to leak slightly under hydrostatic test after installation at the plant at which it was to operate.

Instead of proceeding to close up the leaky points by correcting the defective inside calking, those in charge promptly applied outside calking to all seams. It is such practice which defeats the intention of the builder and puts added burden upon the owner merely to overcome trouble arising from imperfect details that is condemned by Dr. Hall.

Leaky Piston Rings and Valve Test

I READ THE article on Diesel Engine Maintenance in the Nov. 15 issue with interest and I think that my method of testing for leaks may be of interest also. Each cylinder is tested separately. The engine is barred around so that both valves in that cylinder are closed. The engine is then fixed so that it cannot move.

Compressed air is then admitted into the cylinder being tested and a pressure of about 100 lb. allowed to build up, after which the air supply is shut off. Then by listening outside the cylinder the hissing sound of escaping air will be heard, if either the valves or piston rings leak.

By this means, it is possible to detect the exact position of the leakage. If an air pressure gage can be fitted to the cylinder compression cock, the exact fall in the air pressure can be seen and small leaks discovered.

Herts, England. W. E. WARNER.

Arctic Circle Power Plants

IN THE February 1 issue of Power Plant Engineering, page 196, appears the interesting article, "White Lights North of the Arctic Circle." On page 198, in the last paragraph, is a statement to the effect that the power plant at Nome, Alaska, ranks second as being closest to the North Pole. I must take exception to this statement.

At Fairbanks, Alaska, during 1927-28, I helped build a steam power plant having a capacity of 10,000 hp. Fairbanks lies several miles closer to the North Pole than does Nome. Previous to 1927, the Nome plant was the farthest north of all power plants in the western hemisphere. This plant uses Diesel engines as prime movers.

The Fairbanks plant, owned by a subsidiary of the U. S. Smelting, Mining and Refining Co., contains two Stirling type boilers and three turbo generators using superheated steam at 750 lb. pressure. The Nome plant is owned by another subsidiary of the same company.

Both of these plants lie between 64 and 65 degrees north latitude and the Fairbanks plant is some 25 mi. farther north than the Nome plant.

Cold Springs, Minn. CHAS. A. PETERSON.

Improvements Come as Result of Careful Planning

MAINTENANCE IS always the major problem of the operating engineer and it is up to him to keep the plant running regardless of conditions, because there is no one to whom the buck can be passed. Sometimes this falls to the lot of the master mechanic, sometimes the chief engineer and sometimes the plant engineer depending upon what the organization is; but regardless of what he is called, the work must be done. There is a lot of talk about when this repair and maintenance work should be done. It is impossible to deny that major changes and repairs should be made during slack times but no one has to tell an engineer that at such times it is most difficult to get money.

In some seasonal industries cheap plants are put up with little or no spare capacity and that equipment is run at its peak for the entire season without any repairs except in case of an accident. The slack period is used to put everything back into good shape. This is the way it should be where the season is short, two or three months out of the year, and fixed charges must be reduced to a minimum. The whole plan is organized on this cycle and repair work of a costly nature is anticipated and allowed for by the management.

This is not true, however, in other industries where the cycle is 6 or 8 yr. instead of every year. Business goes on from year to year and is expected to pay a profit not over a period of several years but every year. If you make 25 per cent this year, you make 25 per cent and, with the exception of a little bit tucked away in the surplus, it is spent or paid out in dividends, which is the same thing. If you break even next year, you break even and do not figure that the average is 12.5 per cent over two years. Perhaps that is not right but it is what we are up against.

I have always felt that it was best to keep my plant up to the best possible shape at all times and do most of the big work when business is good because it is comparatively easy to get the money at that time; and what is just as important, it is possible to get the men to do the work. Of course, it costs a little more both for equipment and labor. Equipment costs lower a little in slack times and it is possible to pick out the best mechanics and save at both ends.

I like to do as possible as much of my own work and

planning during the slack periods because then I have the time to work out details and do a little figuring without being rushed. Perhaps it is a good plan to have an ideal plant in mind and know just what certain changes will do. To visualize this a person might draw out a diagram of the present plant in black and then over this mark in red ink all the changes that he would like to make to bring the old plant up to his ideal. If each of these changes is marked A, B, C, D, etc., starting at the coal pile and ending up at the vats or conveyors or whatever the equipment for which the steam and power is used, they can be arranged in the order of savings. Then if you begin gradually with the change that will require the least money and show the biggest return, you have a good argument as an opening wedge. One or two will be easy. Keep close track of the costs and if possible arrange to have the accounts kept so that you can get the necessary figures to show whether your estimates have been realized.

Estimates should be conservative but not too much so. It is just as bad estimating to have the savings come out twice as much as you figure as it is to have it come out half. If you can come out fairly close it builds up confidence in the management and you will find that it is increasingly easy to get the other and more costly changes across.

As a matter of principle, it may not be the right or correct way to do but from a practical standpoint it works and after all it's only the workable ideas that you get across that you get paid for.

Springfield, O. F. PAUL.

Time-Lag Prevents Motor from Burning Out

DEFECTIVE PROTECTION resulted in the burning out of one of our squirrel-cage motors. The motor was a 3-phase, 20-hp., delta-wound motor started by a star-delta switch. It was protected by a circuit breaker which was fitted with a no-volt and two over-load coils. The trips were set to operate at 125 per cent overload and had no time lag.

Examination of the motor after it had stopped suddenly disclosed the fact that the starter had been burned out due to breakage of one of the lines connecting the motor and starter, caused by a faulty contact in the starter. The motor had been running single phase, one winding working in parallel with the other two in series.

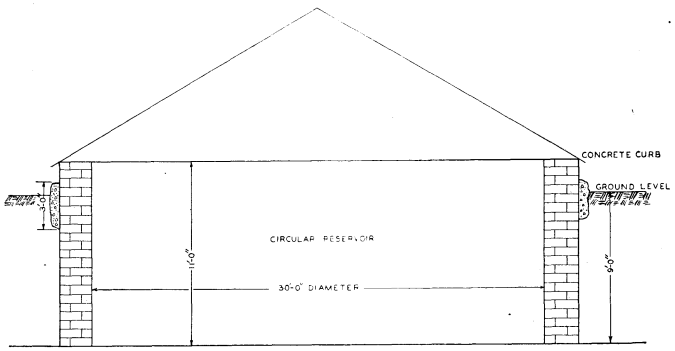
When the motor was working at full-load torque, the current in the phase connected singly across the line would be about twice that which is normal and this would be insufficient to operate the circuit breaker when the trips were set as they were. This flow of excess current had occurred for some time and ultimately had caused the burn-out. The starter contacts were also found to have softened through overheating and were making poor contacts.

In order to afford sufficient protection to a star-delta connected starter which is connected permanently to a circuit breaker, the trips should be set to operate at a slight overload and should be fitted with time lags to take care of the large flow of current when starting and a maximum overload setting of 25 per cent should be attained, if possible.

Herts, England. W. E. WARNER.

Concrete Makes Inexpensive Repair for Brick Reservoir

WE HAVE TWO circular brick reservoirs for city water, as shown in sketch. At the ground level, the brickwork cracked and became in such bad condition that it allowed surface water to seep in during heavy



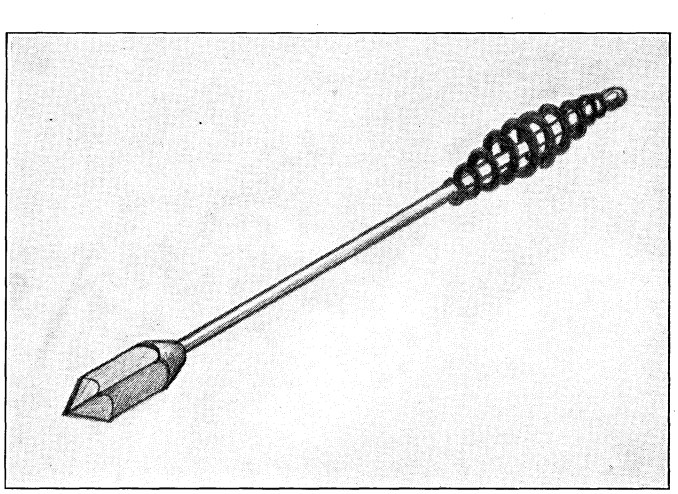
CRACKS IN BRICK WALL REPAIRED BY CONCRETE COLLAR

rains. A trench was dug 2½ ft. deep, and 6 in. wide around these reservoirs and the trench filled with concrete, the concrete being finished up about 6 in. above the ground as shown. The plant owned a gravel pit and the work was done by plant labor so the only money outlay was for the cement. Thus a permanent and cheap repair was made without interfering with the use of the reservoir.

New Castle, Ind. NELSON HOWARD.

Unique Soldering-Copper Handle

TO USERS of the old-fashioned soldering copper that has to be heated in the flame of a torch or fire, the idea shown in the accompanying sketch will surely have an



OLD POKER MAKES COOL HANDLE FOR SOLDERING COPPER

appeal. It is a cool handle made from an old poker by cutting it off to the desired length and drilling out the copper and driving it on as illustrated.

Concord, N. H. CHAS. H. WILLEY.

HIGH SULPHUR in coal causes trouble and corrosion all the way from the railroad car through, and even following, the stack as the sulphur products may combine with moisture in the air to form sulphuric acid.

Questions and Answers

Steam Turbine Foundations

WHAT IS THE METHOD used for installing a steam turbine on a foundation? R. B.

A. Two types of foundations are now in common use: concrete and structural steel. In either case the top is of concrete. Steel foundations are gaining in popularity because of the additional space available beneath the turbine for generator air coolers and extraction heaters. Sometimes the columns are filled with concrete to damp the vibration that is set up by the operation of the turbine.

In the case of concrete foundations, anchor bolts provided with anchor plates are hung from a wooden templet through which holes have been drilled at the exact locations of all foundation bolt holes in the turbine base. Clearance around the bolts is secured by means of pipes or wooden boxes so that the alinement of the machine may be adjusted after it is set and then grouted with neat cement composed of one part cement to one part sand in a thin flowing state of wetness. This grout fills the pipes or clearance boxes so as to secure the bolt locations and fills up any spaces between the foundation and the turbine base. The templet is leveled and set in the exact position to be occupied by the turbine and the bottom of the nut on each bolt is set in the position to be occupied by the top of the corresponding boss on the turbine base.

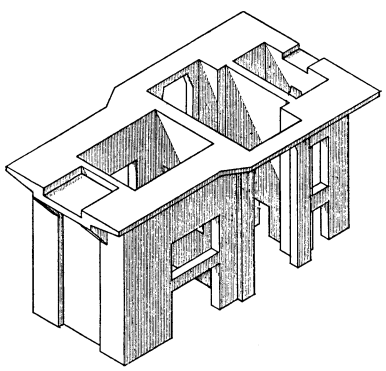


FIG. 1. TYPICAL EXAMPLE OF A MODERN RE-ENFORCED CONCRETE TURBINE FOUNDATION

Instead of using wedges to level the base after setting it on the foundation, a recent method of preparing a level surface for the reception of the turbine is by the use of a large number of sole plates made as shown in Fig. 3. The tops of all bases, both concrete and steel, are left about 6 in. low in numerous spots for the location of sole plates as indicated in Fig. 4. First a thin plate about 6 in. wide and 12 in. long is grouted in at these various locations, then a sole plate casting, supported by three bolts is set on each plate. The design of the sole plate and the locations as shown in Figs. 3 and 4 are for a 20,000-kw. unit. The castings are machined, put in the store room until needed and then remachined, so as to correct any warping or distortion of the casting that may have occurred.

After setting the sole plates, they are leveled by means of a good machinist's level or, preferably, by means of a surveyor's level. One corner of the casting

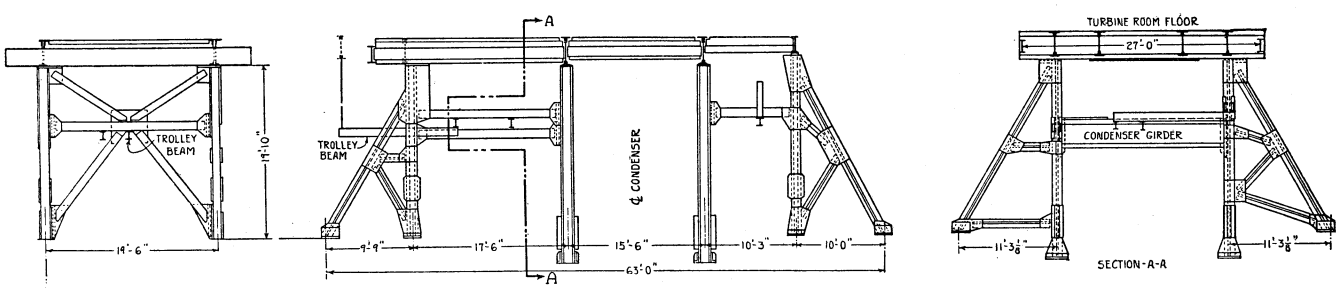


FIG. 2. STRUCTURAL STEEL FOUNDATIONS HAVE MORE OPEN SPACE UNDER THE TURBINE

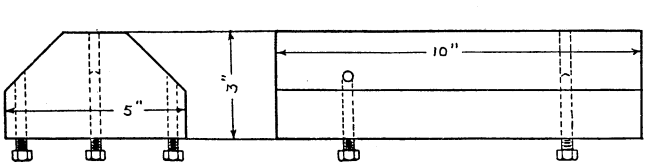


FIG. 3. SOLE PLATES GROUTED IN THE TOP OF THE FOUNDATION SERVE IN PLACE OF WEDGES FOR ADJUSTMENT

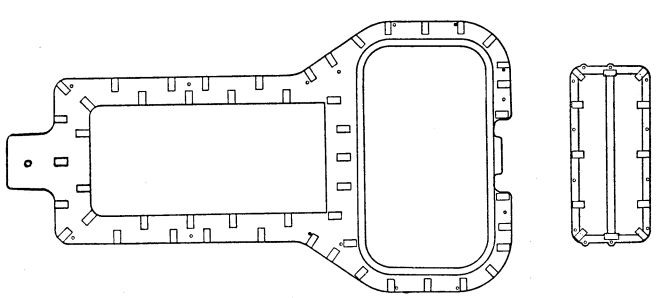


FIG. 4. LARGE TURBINE FOUNDATIONS MAY HAVE AS MANY AS 80 SOLE PLATES

first is brought to exact grade and the casting is then leveled by adjusting the supporting bolts. If in each case, a check by the spirit level shows the setting to be correct; the sole plate is immediately grouted in. Grouting is done either with neat cement or heated lead. For aiding in the alinement of the unit, small lead blocks may be set in the floor, one at the steam end; the other at the generator end and the center line of the unit marked on them.

Two precautions should be observed regarding turbine foundations. The foundation or piers should be entirely separate from the floor or its supports and provision should be made to support the steam main, leading to the turbine, independently of the turbine itself. Well anchored expansion bends or joints and substantially supported piping should be installed.

Cause and Prevention of Pitting

WE HAVE A HIGH-PRESSURE heater which we altered about six months ago for heating feedwater; heavy tube failures have resulted, the tubes becoming full of pin holes. Is this due to electro-chemical action or to air absorption by the water? How can this trouble be prevented?

A. Pitting such as you describe is usually due to entrapped air and other gases. Deoxygenation is accomplished by two general methods, mechanical and chemical.

Oxygen is removed from water chemically by oxidizing iron, steel or other substances in what are termed deactivators, which are iron or steel shells, similar to pressure heaters but filled with trays containing the deoxygenating material through which the water is passed as illustrated in Fig. 1. The gas combines chemically with the deoxygenating material, forming oxides or hydroxides of the metals. The rate of oxygen removal by this means is relatively slower in cold water than in hot water. It is customary in most appliances of this sort, therefore, to heat the water before passing it through the deoxygenating material.

Mechanical degasification is accomplished in deaerators such as illustrated in Fig. 2 where, due to the drop in temperature in the separator, a portion of the water flashes into steam which is passed into the surface condenser where the vapors are condensed and the air is removed by an air pump or ejector. The cooling water for the condenser is the cold water to be deaerated, hence it is heated high enough before entering the heater that a portion of it flashes into steam as it enters the separator.

Another type of deaerator removes dissolved gases by discharging steam into the bottom of the deaerator

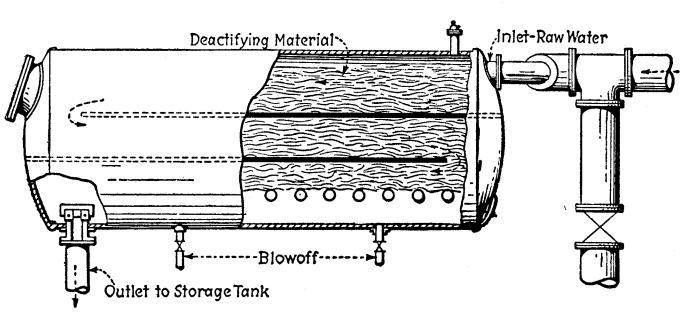


FIG. 1. DEACTIVATOR FOR REMOVING AIR FROM WATER BY OXIDIZING IRON

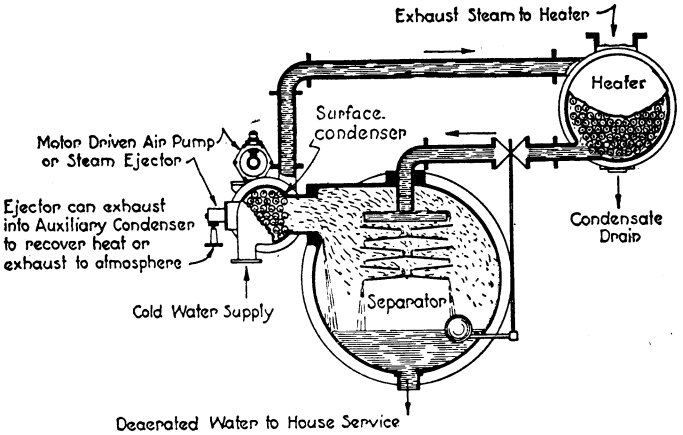


FIG. 2. DEAERATOR WHICH USES MECHANICAL MEANS FOR REMOVING AIR FROM WATER

tank through a series of nozzles. By this means, the gases are swept out of the body of the water by the action of the steam bubbles in passing rapidly upward through the water in a counter-current system.

In this type, the steel shell encloses a series of trays in its upper portion as in an ordinary open water heater. The water enters at the top and splashes over the trays. The steam enters at the bottom through perforated pipes and passes upward through the water in the storage space, heating the falling water. The gas with some vapor is removed by an ejector, the vapor being condensed and returned by the system.

Greensand as a Zeolite Material

PLEASE GIVE me information regarding the use and characteristics of New Jersey sands for use as a water softener. D. W. R.

A. Greensand, which is an excellent natural zeolite material, is found in considerable quantity in southern New Jersey. This material possesses the power of permutation, with respect to the exchange of bases, which is required in the zeolite process of water softening.

Processing of base-exchange silicates, such as the greensand mentioned, is somewhat of a trade secret although the general details for preparing the substance are fairly well known. The greensand is mined, generally, by means of power-driven shovels or scoops or by other mechanical appliance adaptable for this kind of work. Then it is heated in order to increase its hardness and is finely crushed and graded for size. In some cases, the mineral is treated with caustic soda during the processing.

Live Steam for Oil Heating Coils May Raise Temperature Too High

WHAT IS THE objection to using live steam in the heating coil of a fuel oil storage tank? C. A. D.

A. Use of live steam in the heating coils may cause the temperature of the oil to be raised above the flash point of the oil and thereby liberate inflammable vapor.

PERIODICAL INSPECTION and test of belts should be made at intervals of 6 to 8 mo. by a well qualified man who should clean the belt, apply dressing and weigh the tension to make sure that it complies with requirements for best functioning of the drive.

Power and Fuel Engineers Meet at Chicago

FUELS AND METHODS OF BURNING THEM, POWER ECONOMICS, PRIME MOVERS, ELECTRICAL DEVELOPMENTS AND WATER PROBLEMS WERE TOPICS FOR DISCUSSION

PROGRAMS replete with valuable technical data, followed by discussions by outstanding power plant and industrial engineers, engrossed the attention of the several hundred engineers who attended the sessions of the Fourth National Fuels Meeting of the American Society of Mechanical Engineers and of the Fifth Midwest Power Engineering Conference at the Stevens Hotel, Chicago, Ill., from Feb. 10 to 13. An outstanding feature of the meetings was the great banquet and ball held jointly by the two organizations on the evening of Thursday, Feb. 12. Simultaneously with the engineering meetings, the Fifth Midwest Power Exhibition, described elsewhere in this issue, was held at the Chicago Coliseum from Feb. 10 to 14 inclusive.

At noon on Tuesday, Feb. 10, after the usual registration period, the Power Conference opened with a luncheon at which H. W. Fuller, president of the conference, presided. The speaker was Major L. R. Lohr, manager of the Century of Progress Exposition, popularly known as the Chicago World's Fair, to be held in Chicago in 1933. He showed how one of the principal objects of this exposition will be to make clear to the non-technical layman just how science and engineering affect him in his everyday life.

On Tuesday afternoon, the first technical session of the conference began, with C. F. Hirshfeld presiding. In the first paper, A. H. Kehoe, United Electric Light & Power Co., discussed the factors involved in Balancing Plant Investment with Operating Cost, with special reference to electric utilities. Design based on existing similar plant, advantages and disadvantages of pioneering, use of unit type design and standard interchangeable parts, reduction of labor and material costs, relation of load to plant capacity, proper purchasing methods, use of mass production methods in construction, and many other factors must be studied by the engineer to achieve the proper balance.

H. W. Eales of Byllesby Engineering and Management Corp. discussed Advances in Electrical Distribution, pointing out the reasons underlying development of our present systems of transmitting and distributing electricity.

DUAL PURPOSE POWER PLANTS

In discussing this subject, John M. Drabelle of the Iowa Railway & Light Corp., pointed out that, by a little study, central stations can usually be so located that fuel and water supply will be convenient yet steam can be economically supplied to many manufacturers so as to give complete service of light, power and heat.

Mr. Drabelle cited several instances of such coöperation. The Deepwater Station was described in Power Plant Engineering.

Southeastern Production Co. plant at Mobile, Ala., furnishes 85,000 lb. an hr. of 150-lb. steam and 50,000 lb. an hr. of 35-lb. steam to International Paper Co., also 7500 kw. of energy when needed and the mill delivers to the utility system any or all power generated. Louisiana Steam Products Station, coöperating with Standard Oil Co. of Louisiana, was described in the issue of Feb. 1, 1931.

At Rochester, N. Y., 11,750 kw. of turbines, some non-condensing, some bleeder-type, supply steam at 125 and 15 lb. gage for process and heating.

Since 1914, Iowa Railway & Light Corp. has supplied steam and power to Quaker Oats Co. and more lately to hotels, offices and hospitals, present demand being 90,000 lb. an hr. for low-pressure heating, 30,000 lb. an hr. for high-pressure heating and 70,000 lb. an hr. to Quaker Oats Co.

Discussion of Mr. Drabelle's paper brought out the feeling that most of the installations noted were "tailor-made"; that is, it was possible to know in advance the conditions the dual purpose plant would have to meet. To design such a plant for serving a large number of industries, however, would be a much more difficult job.

REFRIGERATION IN AIR CONDITIONING

The evening session on Tuesday opened with Alvin H. Baer presiding. After tracing the development of air conditioning, Willis H. Carrier, president of Carrier Engineering Corp., showed how uses of refrigeration and air conditioning in industry are rapidly increasing and stated that it is in the application of refrigeration to air conditioning for human comfort that the greatest field lies.

Contrasted with power, lighting or heating, central station refrigeration is a new development. Multiple systems for apartments show the tendency and, for favorable conditions, central plant refrigeration will eventually replace individual plants. The problem was discussed by George A. Horne, vice-president of Merchants Refrigerating Co. of New York.

Direct distribution of refrigerant has been used but possibility of leakage or breakage of the distribution system within the buildings served is an objection. Brine circulation, usually of calcium chloride, requires larger mains, greater cost of pumping and lower temperature of refrigerant but its advantages more than offset these objections. As a matter of economics, substantial, concentrated load is essential.

TRENDS IN STEAM TURBINE DEVELOPMENT

Present problems and trends in steam turbine development were treated on Wednesday morning by Professor A. G. Christie of The Johns Hopkins University. This paper is abstracted at length elsewhere in this issue. Alex D. Bailey presided at this session, which was devoted to prime movers.

Discussion of Professor Christie's paper concerned technical skill required to divide load between units, influence of increasing superheat at higher pressures on boiler design, and uses of new metals in turbines. Certain alloys for castings, now under investigation, give

promise, it was stated, of meeting precision requirements. On a turbine now operating with 23 different metals used in the last low pressure blades, to test erosion, interesting results are being obtained.

Fundamental characteristics of design and operation of reciprocating engines for high steam pressures were treated in a paper by John F. Ferguson of Ferguson Engineers.

Influence of Use on Engine Design

After reviewing the various services to which internal combustion engines have been applied, Harold F. Shepherd, of Cooper-Bessemer Corp., discussed the manner in which the particular use to which the engines are put influences the details of their design. More extended abstract of this paper will be given in a subsequent issue.

Discussion of this paper brought out data on a new type of automatic Diesel engine plant recently designed. This consists of a storage battery, booster and Diesel engines, with automatic controls for starting and stopping, regulating fuel pumps, and other features. Starting is electrical, jacket water or lubrication failure shuts down the unit, load is automatically controlled as the storage battery handles the peaks. Enclosed engines in air conditioned rooms are possible, simplifying inspection and attendance problems, better and simpler governors are used and the complication of starting equipment lessened. No provisions are made for low load operation as the storage battery handles low loads, the engine shutting down. Efficiency of 10.5 kw-hr. per gal. net is claimed.

Propeller Type Water Turbines

Increased economy of steam generation was stated by L. F. Harza of the Harza Engineering Co., Chicago, as the reason for demand for less costly hydroelectric equipment. Higher speed of revolution is one way of decreasing generator cost, leading waterwheel manufacturers to develop higher speed types, although the cost of the wheel is but little reduced.

Development of the adjustable-blade propeller type, to permit changing blade angle with variation of load or head has progressed, especially in Europe. First came manual adjustment. Next came provision to change blade angle at the coupling flange between turbine and generator. Recent construction permits changing blade angle, manually or slowly by a small electric motor, while the unit is operating. This is known as the Kaplan turbine and its use in Europe is becoming almost universal for at least part of the units in plants for heads under 60 ft. It is also proving popular in this country since its introduction 2 yr. ago. While efficiency is somewhat lower at normal load than for other types, it is much higher at part load operation.

Power for Pumping Gas, Oil and Gasoline

The Wednesday afternoon session, presided over by R. F. Schuchart, opened with this paper.

Power requirements for transporting crude oil, gas and gasoline are different and the author of this paper, A. E. Harnsberger of Pure Oil Co., discussed them in that order.

For crude oil, main line pumping stations in the early developments in Pennsylvania were usually steam-driven but in the Mid-Continent field, where coal is scarcer and oil cheaper, Diesel engines were often used. Electric drives are now being applied in some cases.

Natural gas lines have increased to 26 in. in size, to 1000 mi. in length, pressures have increased to 600 lb. in some cases and development of welded steel pipe lines has made possible transport of gas to assured markets from newly discovered fields.

Direct-connected gas-engine driven compressors of twin tandem type are usually used for pumping gas. Steam machines may be used when water and fuel conditions are right. Electric drive usually does not reduce any of the other costs of a pumping station, even where current is cheap, because the pumping machinery is usually reciprocating, necessitating cooling water for compressor jackets.

In transport of gasoline, the author describes three new installations that illustrate three distinct forms. In one case, gasoline will be pumped by motor-driven centrifugal pumps. In the second case, it will be pumped by reciprocating pumps driven through reduction gears by airless injection full Diesel engines, the fuel for which at first will be 26/28 gravity oil brought to the stations in tank cars. In the third large project, gasoline will be pumped by centrifugal pumps driven at 3500 r.p.m. through gears by 6-cylinder vertical gas engines using butane as fuel. The butane in liquid form will be sent through the pipe line.

Arc Welding in the Power Plant

William Zorn of the Detroit Edison Co. outlined experience with welding in the construction of piping systems, buildings, uptakes, tanks, stairways, railing, oil switch cells, gondola cars and the like.

For boiler uptakes, welding allows the use of lighter plates at a substantial saving, seams being welded inside or outside or partly each, as most convenient. During the construction of Delray Station, 45 welding operators were used; stair flights were shop cut for erection and welded on the job; some 30,000 ft. of 1¼-in. railing was welded up from 20-ft. lengths. Air ducts, coal breaker housings, air washers and pipe system from 3-in. to 24-in. for pressures up to 125 lb. were arc welded.

Selection of skilled operators and assigning them to the work for which they are best fitted is the most important factor in success.

Laboratory checks on joints and test specimens insure efficient production and progress in skill of operators.

Distribution with High-Voltage Direct Current

C. W. Stone of General Electric Co. described the Thyratron, a recently-developed thermionic tube that can be used to convert alternating current to direct current and direct to alternating. It has been used to rectify frequencies as high as 10,000,000 cycles and steps are now being taken to produce it for voltages as high as 15,000 v., 300 amp. and capacity to about 9000 kw. for 2 units, one on each side of an Edison 3-wire system.

The tube allows current to pass only one way, does not need relays or switches, provides protection against surges. If used to rectify alternating current for transmission as direct current, it eliminates effects due to capacity and inductance of the line, lessens insulation

troubles and so on. It will permit easy interconnection of a.c. and d.c. systems by a stationary mechanism and according to Mr. Stone should have many applications in electrical distribution systems of cities and in industry.

High Temperature Metals

Factors affecting creep, strength ductility, fatigue and other characteristics of metals at the high temperatures of 1000 deg. F. or more to which they may be subjected in modern power plant equipment were discussed by H. W. Spring of Crane Co. at the luncheon meeting held under auspices of the A.I.M. & M.E. on Feb. 11., at which C. C. Whittier presided. A detailed abstract of this paper appears elsewhere in this issue.

At the Thursday morning session of the conference, at which Professor F. G. Straub presided, the first paper by S. E. Tray dealt with Developments in Evaporator Design and Practice. He pointed out that the evaporator, in addition to providing distilled water for boiler feed, can also be used as a feedwater heater and as a deaerator. He discussed types of evaporators, gave details of the evaporators as used at Deepwater Station for supplying steam to an industry (previously described in Power Plant Engineering), also of a reducing valve evaporator system.

Concentration Control of Boiler Water

Several methods of checking boiler water concentration that are in successful use in various plants but that vary widely in speed and accuracy were discussed in this paper by Herbert S. Whiton, of Byllesby Engineering & Management Corp. Hydrometer and titration tests are described; these are of value in any plant, it is stated, but as the feedwater treating problem becomes more complex they must be augmented by other tests. In such cases, procedure may include tests for: concentration of total salts, carbonate and hydroxide ions, chloride ions, phosphate ions, sulphate ions, pH values, oxygen, CO_2 content.

In the final session of the Power Conference, presided over by Gen. Charles Keller, Dr. M. M. Leighton, chief of the Illinois Geological Survey, discussed the need for knowledge of geology in engineering projects, where the geologist can often bring about large savings in cost of dams, reservoirs and other structures. He showed a map of geological conditions of the United States and pointed out how the characteristics of the various sections influence the engineer's work.

Major R. F. Kelker gave details of the subway to be built in Chicago. One of its most important features is a concourse in State St., just below the street level, the full width of the street and extending through the Loop with entrances to shops on either side. This is for pedestrian traffic, with the four-track subway below it. Two through subway lines will be built at present, with others planned for the future. Robert Ridgway, consulting engineer for the New York and Chicago Subways, gave details of engineering as carried on in New York, to show the problems encountered in building subways.

At the banquet and ball held jointly by the Power Conference and the Fuels Division on Thursday evening at the Hotel Stevens, a pageant of power was presented during the banquet. Following dinner, O. H. Caldwell spoke on The Electron—Midget Ruler of the Universe, a demonstration of vacuum tube and photo cell phenomena was given and selections were played on the Theremin.

A. E. Grunert presided at the first session of the Fuels Meeting on Wednesday afternoon, Feb. 11. Use of Refinery Waste Fuels in Modern Steam Plants was described by H. L. Klotz of Stone & Webster Engineering Corp. He discussed in detail the Louisiana Steam Station, described in the Feb. 1, 1931 issue, showing the methods of storing and burning acid and alkaline sludges, oil and petroleum coke, and other wastes.

Economics of Fuel Utilization

Calling attention to the rapidly changing character of the fuels available and the tremendous improvements in equipment for burning them, Albert L. Brown, The Consolidation Coal Co., reviewed the development of natural gas, the increasing importance of petroleum and the position of coal as the primary fuel of the country.

Dr. Max Toltz, consulting engineer, described dehydration of low-grade fuels, especially lignite. The Fleissner process has been applied to North Dakota lignite. The material is brought directly in contact with saturated steam at 185 lb. pressure; during a preheating period the pressure is raised to a maximum; a heating period follows; then a release period and an aeration period. As a result, the lignite shows the physical appearance of washed coal, B.t.u. increases from 6800 to 9500. The Evesmith process, utilizing heat from combustion, has also been used, increasing the B.t.u. value of the coal about 40 per cent.

At the evening fuels session on Wednesday, E. L. Beckwith presiding, small stokers, for 200-hp. boilers or smaller, were discussed by T. A. Marsh in a symposium prepared by Midwest Stoker Association. C. A. Connell, Anthracite Coal Service, described in his paper the research work in burning anthracite coal on stokers conducted by his organization. W. D. Edwards, Memphis Power and Light Co., gave data on use of natural gas in Memphis, methods of estimating gas consumption and operating data for various types of plants converted to gas fuel.

With J. Van Brunt presiding, the Thursday morning session opened with a paper on Slag-Tap Furnace, by A. L. Baker of Sargent & Lundy, Inc. He traced the development of this type of furnace, showed the troubles experienced under various conditions and how they have been solved. He stated that the slag-bottom boiler is in process of major development, that it has several advantages which compared with the disadvantages, indicate that it has justified the efforts expended to date. Data were presented on the three boilers at Michigan City equipped with these bottoms, with test data on the slag and ash.

Pulverized-Coal Firing and Study of Combustion

In this paper, Henry Kreisinger, of Combustion Engineering Corp., discussed first the development of water-cooled furnaces, then of the vertical, horizontal and tangential methods of pulverized coal firing.

After discussing the theoretical aspects of combustion of fuels (coal, gas and oil), involving air requirements for combustion, contact between air and coal,

concentration, mixing in furnace, the author concludes that:

Intensive mixing in the furnace is the most important factor within the control of designer and operator for producing rapid combustion.

Mixing outside the furnace is ineffective in producing rapid combustion because a uniform mixture of air and coal cannot be maintained.

Mixing in the furnace tends to keep the coal particles uniformly distributed across any section of the stream and makes the atmosphere surrounding the coal particles a homogeneous mixture of gases.

Combustion constantly destroys equalized concentration; mixing reëstablishes it. Beyond such constant equalization of concentration, mixing can have no further effect on rapidity of combustion.

Presenting a paper on Accuracy of Weighing and Analyzing Coal, F. W. Martin of Sargent & Lundy, Inc., and E. Mandel of Commonwealth Edison Co., analyzed results obtained in a series of coal weighings and sampling from various stations involving some 500 coal samples.

At the Thursday luncheon session with the Power Conference, W. Trinks presiding, A. C. Fieldner, U. S. Bureau of Mines, spoke on Recent Developments in By-Products from Bituminous Coal. After pointing out that the byproduct oven has displaced the bee-hive oven as a producer of metallurgical coke, he discussed increasing value of byproducts as compared with coke and gave details on various technical methods of recovering byproducts.

Pulverization and Boiler Performance

This paper by E. H. Tenney, chief engineer of power plants, Union Electric Light & Power Co., gives specific and practical information on the relationship of pulverization of coal to boiler performance. A more detailed abstract of the paper appears elsewhere in this issue. It was the first on the Thursday afternoon program, Geo. F. Gebhardt presiding.

The second paper, Radiation in Boiler Furnaces, by N. Artsay, assistant to Geo. A. Orrok, worked out formulas for radiant energy absorbed by air-cooled and water-cooled furnaces, gave experimental data showing the extent of agreement between computed and actual results.

Reduction of Unaccounted for Losses in Boiler Tests, by W. F. Davidson, Brookly Edison Co., showed how boiler efficiencies have now reached a stage where further improvement demands accurate knowledge of all performance factors.

An important factor in unaccounted-for losses was suspected to be the presence of unburned hydrocarbons in the flue gas. The author described the equipment devised for flue gas analysis but the results of tests indicated the presence of unburned hydrocarbons affords only a partial explanation of unaccounted-for losses, and much more study is needed.

A. A. Potter presided over the Friday morning Fuels session, in which the first paper was on Pioneering in Selection of Boiler Equipment. On this subject, F. H. Rosencrants of the Combustion Engineering Corp., New York, outlined reasons why development of new types and methods must be by sympathetic cooperation of manufacturers and plant owners, usually in central station plants, since fuel is so much more important an item of total cost of plant operation than in an industrial factory, hence saving in fuel justifies the possible hazards of pioneering work. The author repeated an earlier opinion that interest in high pressure would lessen in favor of moderate pressure and higher temperature.

Standardization except in details is undesirable since skill and judgment of designers and operators are the foundation for progress and development.

Future Boilers

Geo. A. Orrok of New York, after reviewing past developments in practice and conditions of modern boiler room operation made the prediction that, since liquid fuel can provide only a small part of the power needed, boilers of the future will be gas fired. While some power will be generated by combustion engines, he felt that cheapness, flexibility and possibility of large sizes will keep the steam boiler in use as long as heat engines are the main source of power. Coking plants and complete gasification plants will supply pipe line system which will deliver the gas for plant operation and heating. Boilers of small size and large capacity, with small combustion space, rapid circulation, high rate of heat transfer, safe design and high efficiency will be developed. Smoke and dust will be eliminated, so that boiler, turbine and generator will be in one room in a compact arrangement.

Discussion of these two papers centered around supply of gas for fuel as suggested by Mr. Orrok, methods for preventing atmospheric pollution, economic factors and so on. Data were given on complete gasification plants now in operation in this country and abroad.

Burning Missouri-Kansas Coals

Bettering of the coals, which are naturally high in ash, sulphur and moisture, of low fusion temperature and irregular quality was discussed by E. L. McDonald of the Kansas City Power and Light Co. The period covered was 25 yr. and the equipment chain grate stokers.

Ash and moisture have been reduced by more careful mining and picking, induced by purchase on a B.t.u. basis, the result being increase in B.t.u. per pound as great in some cases as 1000 and averaging, for six sources over a period of 5 yr., 800 B.t.u.

Improvement in equipment has been by increase of vertical flame travel through higher settings, increase of horizontal travel by longer chain grates and furnaces, change from a sloping bridge wall to an overhanging type, zoned forced draft, air preheating, wider spacing of lower tube rows, supply of overfire air, water-tube side walls, and radiant superheaters. By such means, greater capacity, lessened slag troubles, increased heat release per cubic foot of furnace and higher combustion rates have been secured. The results are combustion rate increased from 55 lb. maximum to 65 lb. and capacity from 100,000 lb. of steam an hour from 20,843 sq. ft. of heating surface to 175,000 lb. an hr. from 20,900 sq. ft. Higher furnace temperature, with more rapid heat absorption accounts for the gain.

The first paper of the Friday afternoon session, John

Hunter presiding, was on The Fly-Ash Problem. This was presented by H. H. Bubar of New York, president of Dust Recovery, Inc.

As data on the subject, it was stated that with 9 to 11 lb. of steam per pound of coal of 12 per cent ash, a station making 1,000,000 lb. of steam an hour produces some 7 t. of fly ash; one making 5,000,000 lb. an hour produces 40 t. Of this the ashpit catches from 10 to 60 per cent, the average going to the stack being 70 per cent.

From 4-yr's. study of the problem, the author found that 1.5 per cent of the fly ash will be caught by a 100-mesh screen; 4.5 per cent on a 200-mesh; 9 per cent on a 300-mesh. The remaining 85 per cent will pass through 300-mesh. Microscopic study showed that of the total dust, 50 per cent is less than 20 microns diameter and 27 per cent is less than 10 microns. (A micron is 1/25,000 in.) Particles 25 microns diam. at a height of 200 ft. will travel 16 mi. in a 10-mi. per hr. breeze before falling to the ground; 12-micron particles will travel 65 mi. The latter will diffuse so as to form no nuisance.

Removal, therefore, of particles caught by a 300-mesh screen and of a large percentage, 70 to 80 per cent, of the balance would eliminate dust nuisance, while failure to remove the coarser than 300-mesh particles, even though the method removed 90 per cent of fly ash, would be unsatisfactory.

In the discussion, further data were presented on measurement of fly-ash, amount of discharge that constitutes an offense and the basis on which ordinances concerning stack emission should be based. Two cases were presented giving comparison of emission on the basis of grains per cubic foot and of per cent of coal burned. Engineering considerations are accurate sampling of solids in gas steam, determination of sizes of solids and degree of pollution of the atmosphere. It was urged that legislation proceed slowly, increasing severity of ordinances as technical developments increase.

Ely C. Hutchinson reviewed the work done in smoke abatement in this country and in Europe.

Col. E. H. Whitlock discussed the work of the Hudson County Smoke Abatement Commission and emphasized that a smoke ordinance should provide for an engineer to head the organization, for engineers on the board and for units to define violation. The ordinance should contain no details on smoke or its prevention; these should be considered in each case by an advisory board of engineers.

Victor J. Azbe, consulting engineer, discussed industrial and domestic smoke, showed how smokeless coal and proper methods of firing it were needed by domestic users and stated that since the paths followed for years to eliminate smoke had not succeeded, it was time to try new methods. H. B. Meller emphasized that legislation must follow development and that there must be more interest by engineers in even the smallest furnace.

General discussion of air pollution followed, emphasizing the need for engineering programs in its elimination, the uses of publicity in emphasizing prevention of waste and continuous effort not only to lessen smoke and air pollution but to eliminate it.

New York Edison to Spend $48,000,000 in 1931

MATTHEW S. SLOAN, president of the electric companies in The New York Edison System, has announced that a construction budget of $48,167,300 had been adopted for 1931. That sum is apportioned by companies as follows: The New York Edison Co., $5,520,100; Brooklyn Edison Co., $20,435,000; The United Electric Light & Power Co., $6,329,200; New York & Queens Electric Light & Power Co., $15,111,000; The Yonkers Electric Light & Power Co., $772,000.

The budget contains items for generating stations, $11,409,200; substations, $652,600; buildings and yards, $142,000; transmission and distribution, $35,148,200; miscellaneous, $815,300. Of the expenditures for generating stations, $426,000 will be for structures and equipment at the East River Station of The New York Edison Co.; $1,833,200 for equipment at the Hell Gate Station of The United Electric Light & Power Co.; and $8,711,000 for the Hudson Ave. Station of the Brooklyn Edison Co., of which sum $8,290,000 is for two 160,000-kw. turbo-generators to go into service this year (1931) and next.

The largest item in the budget, $35,148,200, will be expended for improving the distribution systems of the companies and particularly for removing overhead pole lines in Brooklyn and Queens.

For Brooklyn $7,394,000 has been appropriated for conversion of overhead lines to underground in the Greenpoint, Evergreen, Bushwick, Ocean Parkway, East New York and Park Slope sections. Removal of overhead lines from 171 mi. of streets is provided for. In the Brooklyn budget is also an item of $2,000,000 for general improvements to the distribution system.

For Queens $7,793,000 has been appropriated for the removal of overhead lines; $1,045,000 for extensions of service and mains, and $4,812,000 for building subways for mains, and general improvement of distribution system. The areas in Queens scheduled for change-over from overhead distribution to underground are Jackson Heights and Woodhaven. Distribution lines on 47 mi. of streets will be put underground in those sections.

The budget contains for street lighting improvements and equipment items of $414,500 for Manhattan and the Bronx; $293,000 for Brooklyn; $275,000 for Queens, and $18,500 for Yonkers.

"Our construction budget for 1931 is smaller than that for 1930 by approximately $28,000,000," said Mr. Sloan. "That is because we are now built well ahead on generating plant capacity, especially since the demand for current during 1930 did not increase at its normal rate. Our chief activity this year will be enlarging the capacity of our distribution system and generally improving it. We have provided for an extensive program of changing overhead lines to underground, which will yield a more reliable service and vastly improve the appearance of the streets and benefit property in those sections where the lines are placed underground."

DIRTY, poorly illuminated engine and boiler rooms lead to careless methods of operation consequently lowered efficiency.

Editorial Comment

Public Ownership Steps Out

Notably, in the past, public ownership of utilities has been fostered by notoriety-seeking politicians for personal advantage, with little regard to the real interests of the public. Thirty years ago conditions favored installation of municipal utilities. Many communities, too far from existing central stations or distribution systems to be economically supplied and with too little demand for power or light to be attractive as a field for private investment, could, by comparatively moderate investment provide themselves electric service. As accounting was not well worked out, by overlooking depreciation, upkeep, taxes and other overhead, labor and fuel costs only being considered, this service seemed to be secured at very low rates and was priced accordingly.

Results of this development still continue to plague utility management, both private and municipal, which is trying to give service but is honest as to costs. Extension of distribution networks made electric current, developed in economical stations, available for most communities and the day of reckoning, when plant began to wear out, revealed the fallacy of neglected overhead, so that from 1915 taking over of small municipal systems by private utility companies was rapid. Some larger ones, which were operated on an engineering rather than a political basis, have adopted adequate accounting systems and are getting satisfactory results. Sane advocates of public ownership are advising that retention or installation of a municipal system be based on good engineering and finance instead of on political or socialistic considerations and that the equivalent of taxes that would be paid by a private company be included in the overhead cost of operation of the system.

If this were done in all cases, comparison of the advantages of private and public ownership of utilities would be simple. Unfortunately, the advice has not been universally followed but, except for those who use baiting of utility companies and the alleged "power trust" as part of their political thunder, the tendency seems to be toward consideration of facts rather than fancies.

For federal projects, the facts are still much "needled" with local advantage and arguments must be carefully distilled to remove the adulterations. Federal control seems likely, however, to expand, since interstate transmission of power is increasing rapidly. Perhaps this will, in the end, be of benefit to private systems as state control has, in some cases, shown a narrow attitude toward export of power.

Also there arises the question of how far it is good economy to expand distribution networks. Opinion has been advanced by some that it is already, overdone, claiming that efficiency of generation increases rather slowly with size of station and generating units above a certain point while cost of the long-distance, high-voltage distributing system is more than of smaller stations located near to load centers. Setting up of federal control might serve to bring the point of whether there be overexpansion into the open for examination.

As against this view is the movement in some states to allow formation of public utility districts with distribution networks to be supplied by plants owned by the districts. If this becomes general, it may set up argument for competition within state lines that will be difficult to meet unless consideration can be focused on real engineering and financial facts with political perquisites and socialistic theories eliminated.

The best service possible to the community at the lowest cost consistent with sound engineering and financial operation should be and in nearly all cases is the aim of the public utility management. To rely on the consciousness of a job well done may, however, be insufficient. The new line of attack by public ownership advocates seems to indicate that they will take advantage of modern developments to bring in ever larger publicly-owned competition, thus giving more opportunity for patronage and complicating the problem of ascertaining real costs of operation.

In an artificial political district which has but one common interest and differs on others, it is difficult to arouse united interest and action when abuses and bad management appear. This is now evidenced by the conditions of Cook County, the City of Chicago, the Sanitary District and various Park Boards, whose jurisdictions overlap and interlock with the result that politicians coöperate for their control while to bring home the blame for extravagance and mismanagement to the real offenders is beset with the greatest difficulty. Consolidating all responsibility into a single governing body is now advanced as the wise course by many who have studied the question.

In the light of this experience, it would seem possible to convince communities not yet saddled with such a governmental jumble of the unwisdom of acquiring one. But one never can tell. Facts are stubborn things but not so stubborn as some people's theories.

Why Are Welded Boiler Drums So Long in Coming?

Contrary to popular opinion, agitation for welded boiler drums and pressure vessels covered by code goes back many years. Preliminary hearings were held before the A.S.M.E. Boiler Code Committee as far back as 1911 and the first Boiler Code edition in 1914 provided for forge welding with an ultimate strength of 28,500 lb. per sq. in. in 47,000 to 55,000 lb. per sq. in. steel plate. This was allowable stress retained in the 1918 edition but was increased to 35,000 lb. per sq. in. in the 1924 edition. That fusion welding was seriously considered is shown by the sentence definitely forbidding its use except in cases where the load was carried by other construction. The present proposed specification for fusion welding of drums or shells of power boilers was published in March, 1930. It provides for maximum work-

ing stress in a welded joint as one-fifth of 80 per cent (or 16 per cent) of the minimum specified tensile strength of the plate. Many feel that this should be increased to 90 or 100 per cent. In Germany, practice for forge welding ranges from 0.3 to 0.9 (depending upon the method used) and for fusion welding from 0.5 to 0.65 (depending upon the subsequent annealing).

Progress in this direction has been less rapid than it might have been but much of this delay can be attributed to the attitude of the welding companies and the apparent mistrust and suspicion with which they regard one another. Each one independently plowed through the same field to discover the same elementary principles and reach practically the same goal. They guard with jealous care what is probably an empty hat and discuss with infinite caution exhaustive tests apparently made only to enable them to tell of the millions spent on their development work.

So shackled with words, progress has been slow and the reason for the delay is clearly pointed out by the following address recently made before the A.W.S.: "Manufacturers of pressure vessels, some gas welded, some arc welded and some resistance welded, come to these meetings and tell of the great numbers of such vessels which they each make each year and of the many millions of dollars of value represented by them. The pressure vessel committees, deeply conscious of their responsibilities in establishing rules to govern this important industry, plan researches which would cost a few tens of thousands of dollars. The manufacturers and users and others who would presumably be interested are asked to contribute to the cost of these researches.

"Out of the many dozens of firms approached, perhaps about five firms undertake to contribute to the costs, but to the extent of only a few hundreds of dollars each. This is all that small firms ought to be expected to contribute but is disappointing in the case of the important concerns whose representatives in the discussion of papers never mention a sum less than a million dollars when describing their research activities. There is a striking contrast between the general suggestions in the discussion of papers that many of the firms are spending millions to put the final touches of perfection on their wonderful products and the ultimate admission that very few of them will put up even a few hundred dollars apiece to determine elementary things, which it is absolutely essential to know, if guesswork is to give place to reasonable certainty."

The Windowless Factory Is Here

For several years the idea of windowless buildings has been discussed pro and con by architects and engineers, a great deal of the discussion being con. Those who had the temerity to state definitely that it couldn't be done are now in the same position as the men who pronounced the aeroplane impossible. For the idea of the windowless building has now crystallized into actuality and the Simonds Saw and Steel Co. is planning to build such a structure at Fitchburg, Massachusetts.

It is to be a factory building of single-story construction, designed with no partitions and only 56 interior columns in the entire structure, with a total area of 207,000 sq. ft. Machinery layout has been planned for straight line production.

One of the principal objects of the design is to create an ideal working environment for each employe. Noise will be eliminated by removing its causes, so far as possible. Uniform artificial illumination to produce an intensity of 19 foot candles at the working plane, without glare or shadows, will be provided. Every 10 min., over 500,000 cu. ft. of air, at proper humidity and temperature and properly cleaned, will be brought into the building. This, together with all necessary heat, will be under automatic control. The color scheme of the interior has also been carefully worked out to reflect light properly and to obtain a favorable reaction from the occupants.

With the psychological effects of eliminating windows and the physiological effects of air conditioning on the workmen we have no concern here. The important fact is that all these conditions are expected to benefit the workman, increase his enjoyment in his work and, together with a higher use factor of the equipment and concentration of activities of three old plants in the new one, to increase factory production about one-third. If such an arrangement succeeds in doing this, at the same time improving working conditions, it will doubtless exert a profound influence on our present production scheme and will silence the Doubting Thomases who are always on hand to belittle the work of the pioneer.

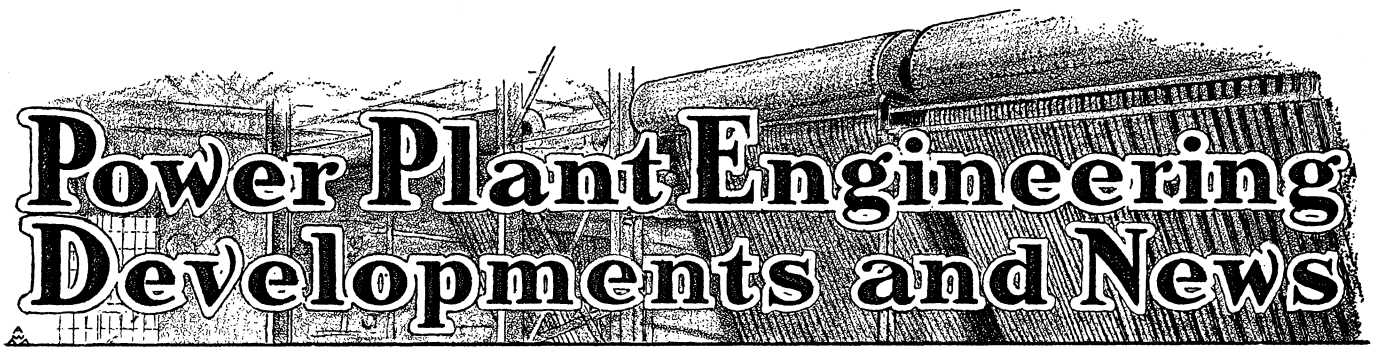
Research and the Plant Engineer

Although we must look to research, science and invention for advancement of the industry, it is difficult for the small plant engineer to appreciate fully changes and improvements that have been made or that are impending.

To study research reports and new lines of investigations thoroughly does little good, however, unless the engineer has some facilities for carrying on investigations of his own or has the ability and data to interpret the work of others. If the process or investigations are still experimental, it is unlikely that the average small engineer can obtain sanction to spend money on it but, if it has been tried successfully by some large works capable of financing the investigation, he is more likely to be successful.

The large central station has been a proving ground for the development of new ideas and the results of their investigations should be of inestimable value to the small station or industrial engineer. The results must not be considered as a working guide, however, but more of a text book as a means of increasing his general knowledge of the subject.

No capable engineer expects to find his problems completely solved in a text book or magazine. No one idea can be taken from one plant and applied to another without change. Study of a dozen similar problems and their solutions, intimate knowledge of new research activities and the natural ingenuity of a good engineer should enable him to solve his own problem in a satisfactory manner. A study of research investigations is seldom of direct value to an engineer but properly correlated with his past knowledge and experience assists him in weaving a background which holds his practical experience together.



Power Show Exemplifies Industrial Progress

FIFTH POWER SHOW HELD FEBRUARY 10-14 AT CHICAGO IN CONJUNCTION WITH THE MIDWEST ENGINEERING CONFERENCE AND THE FUEL SECTION OF THE A. S. M. E.

SUCCESSIVE STEPS in the progress of an industry must be dated, not from the inception of new ideas and equipment but from the time that they are available to the trade. Power shows have been of assistance to manufacturers in presenting details of their equipment to the public in a personal way and each show has recorded successive advances of the industry as a whole. This, the fifth Power Show, was no exception and although no equipment of a sensational character was offered, the detail of refinement evident in all exhibits, indicated the advanced state of the art of generation and utilization of steam and power.

Evidence of impending improvements were evident from the widespread importance placed on welded boiler drum construction by several manufacturers and the almost universal interest in special corrosion and heat resisting alloys, while an additional touch of interest was added by a boiler unit in actual operation. This last exhibit was made up of equipment supplied by various manufacturers. A boiler test was run each day and the steam generated used for heating the exhibit hall. Showing equipment in actual service operation has been advocated by us, editorially, for the past three years and undoubtedly further advances of the practice will do much to increase general interest in the show.

FUELS HANDLING AND FIRING EQUIPMENT

Perhaps the most striking feature of the show was the large number of exhibits devoted to small stokers designed particularly for the utilization of Midwestern coal. With the exception of the working model of a link grate stoker of the Westinghouse Elec. & Mfg. Co. and the full size model of the Stowe compensated feed stoker of Johnson & Jennings Co., the dozen or more stoker exhibits were types designed primarily for small boilers.

The new "14" Junior stoker of the Illinois Stoker Co. is a small chain stoker designed for boilers of from 100 to 250 hp. built for forced or natural draft and designed so that the ash pit can be entirely above the floor and excavation unnecessary. Combustion Engineering Corp. showed the new C-E stoker unit, an underfeed stoker made in three models, ranging in size from 10 sq. ft. to 28 sq. ft. grate area. Riley Stoker Corp. demonstrated improvements on the Jones Stoker. The Chief underfeed stoker of the Marion Machine, Foundry & Supply Co. is an underfeed stoker with a screw feed and built in sizes up to 225 hp. The Auburn Junior of the Auburn Stoker Corp. is a new hydraulic ram stoker made in sizes to take care of from 1500 to 6000 sq. ft. of radiation and intended as a companion stoker to the Auburn underfeed, to give a complete line of 12 sizes, ranging from 1600 sq. ft. of radiation to 500 hp. A hydraulic underfeed stoker was exhibited by the Delta Stoker Co. and a new model of the Iron Fireman of the larger size and with the motor raised above the floor level was featured by the Iron Fireman Mfg. Co. Other small stoker exhibits included the improved type C of the Whiting Corp.; the Firite automatic stoker of the Hoffman Combustion Engineering Co.; the Combustioneer, Inc.; Modern Coal Burner of the Modern Coal Burner Co. and the Pulverzone of the Cokal Stoker Corp.

Pulverized coal came in for less attention than in former shows and the exhibit included but four pulverizers; the new Fuller Lehigh Co. Type B pulverizer, an air separation ball mill using two rows of balls; a new small (500 lb.) Raymond mill exhibited by the Combustion Engineering Corp., who also showed the use of ball mills for unit firing; a new Model No. 4 pulverizer by the Riley Stoker Corp. in which the pulverizer and exhauster chambers are brought closer together; and an up-to-date model of the Strong-Scott Mfg. Co. Unipulvo. Riley Stoker Corp. also featured the new Cyclone turbulent burner as installed at Cahokia.

Considerable attention was attracted to midwestern coals by the exhibits of the Old Ben Coal Corp. featuring method of separation and cleaning of coal and the exhibit of the Sterling Midland Coal Co. showing motion pictures of their method of cleaning and handling coal at the mines, while an operating model of Sauerman power drag scraper was featured by Sauerman Bros. to show modern coal storage practice. Link-Belt Co. exhibited an operating model of a rotary railroad car dumper and the Richardson Scale Co. demonstrated, also by means of a model, the newly developed Convey-O-Weigh, a conveyor scale designed to deliver lumpy, crushed, granular or powdered materials of predetermined weights either intermittently or almost continuously.

Each day an 8 hr. test was conducted on the boiler mentioned above by the Commercial Testing & Eng. Co. using a different kind of midwestern coal each day.

The boiler was a Kewanee Boiler Co., 70 hp. Type C fired by a Whiting Corp. Harrington stoker and equipped with Foxboro Co., Hays Corp. and Republic Flow Meters Co. instruments; Boiler Room Improvement Co., Eclipse smoke indicator; Consolidated Ashcroft Hancock Co. safety valve; New York Blower Co. forced draft fan and a Chicago Fuel Saver Co., Field barometric draft control. The stoker was driven through a Cleveland Worm & Gear Co. speed reducer. Other manufacturers supplying equipment were H. T. Barton Co., Chicago Firebrick Co., Illinois Fireproof Covering Co. and Permo Seal Co. Coal for the first three days was supplied by the Binkley Coal Co., the Electric Coal Co. and the Old Ben Coal Corp.

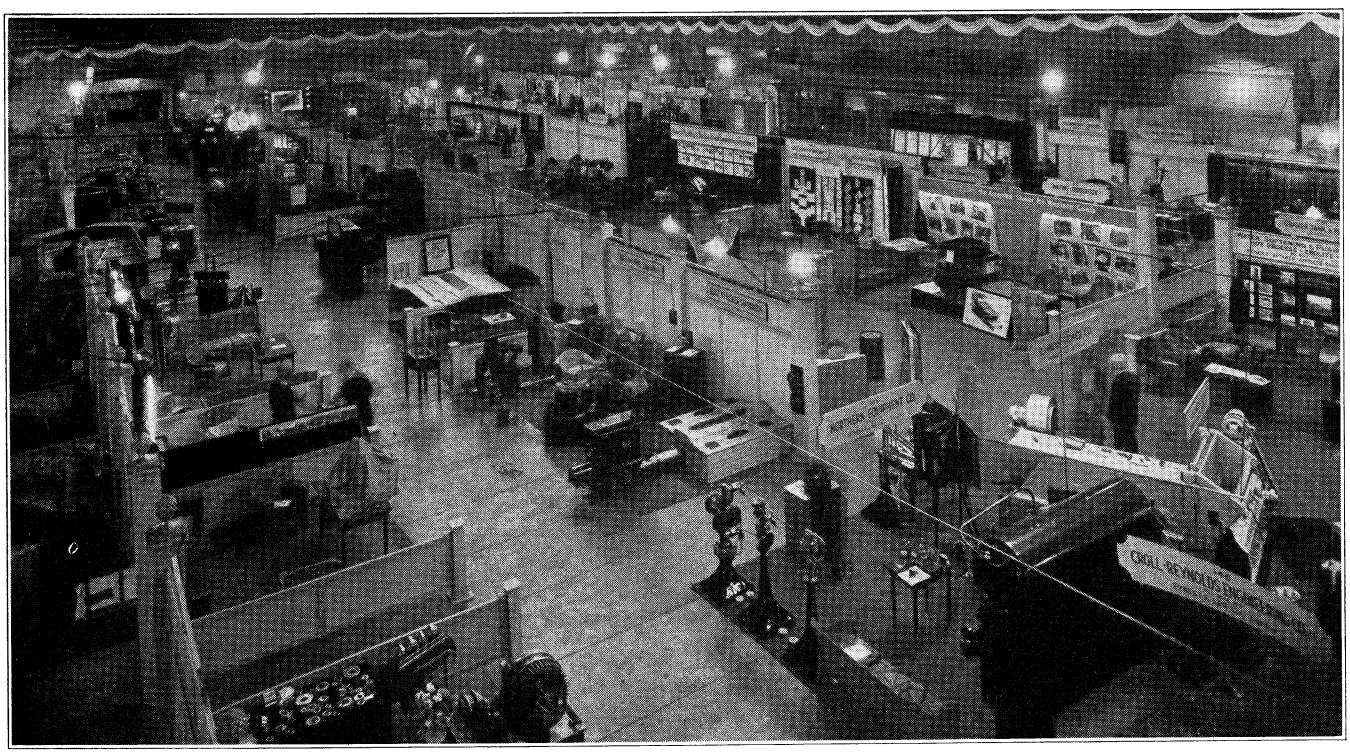
Boilers and Accessories

Fusion welding of pressure vessels was featured by the Babcock & Wilcox Co. by means of a large exhibit of test specimens and microphotographs and welded drums or pressure vessels which had been tested hydraulically were exhibited by the Combustion Engineering Corp. and by the Titusville Iron Works division of the Struthers Wells-Titusville Corp. The former was a 34-in. I. D. drum tested to about 3250 lb. pressure and the second was a 20-in. drum which had been tested to 5000 lb. pressure. Both drums showed considerable distortion, but no indication of a failure in the weld. Welding for boiler repair and maintenance work was demonstrated by the David H. Smith & Sons by means of the Smith-Waters Arc Welders of the portable alternating current constant arc type.

Application of Apexior protective coating to boilers by means of newly designed tools was featured by The Dampney Co., while Sealkote, a new boiler wall coating which is waterproof and airproof, and which can be painted after it is allowed to dry was demonstrated by the Dearborn Chemical Company.

Three new high pressure gage glasses and water columns were exhibited: The Loose Window construction of the high pressure flat gage glass of the Diamond Power Specialty Corp. is designed for high pressure and is so constructed that the glass itself is virtually loose and acts only as a support to the mica. Forged steel water columns of the Yarnall-Waring Co. are now built with a solid bolted top with no stuffing box and the cutting action on the gage glass is eliminated by special condensate grooves. The new gage glass and water column of the Wright-Austin Co. uses a round glass with forged steel mounting pieces intended to give the necessary rigidity and equalize strains in glass and column.

The Vulcan Soot Cleaner Co. exhibited the new Model J head, with a ball and stocket joint at the wall and special supporting brackets to support the head, while the Northern Equipment Co. exhibited for the first time a Copes Class OT feedwater regulator designed particularly for oil field and Scotch marine boilers. It is the tension type made in sizes up to 2½ in. Another exhibit which attracted a great deal of attention was the model of the Ford Motor Co. 1350 lb., 750 deg. temperature Ladd boiler exhibited by The Superheater Co. to show the application of the Elesco superheater designed to handle 700,000 lb. of steam per hour.



Boiler Auxiliaries

Construction and application of Connery & Co.'s breechings and improved generator air cooler ducts was demonstrated by Connery & Co. by means of models. The Buffalo Forge Co. had on exhibit one of the rotors of the 243,000 c.f.m. induced draft fans, said to be the largest ever built, for the Waukegan Station. These fans are driven by two motors, one a 325-hp., 485-r.p.m. slip ring motor for normal service, the other a 900-hp., 645-r.p.m. constant speed motor for peak load conditions. Allen-Sherman-Hoff Co. exhibited full-sized models of their new Type C Hydroseal ash pump with a chrome-molybdenum-nickel, heat treated and ground runner and a chrome plated shaft. Chicago Fuel Saver Co. exhibited several models of the Field fuel saver, a device to

automatically regulate the draft on natural draft boilers. Manhole ventilators were featured by the Coppus Engineering Co.

Furnaces and Refractories

Furnace wall construction of the solid, air-cooled and water-cooled types were exhibited by many companies. The Drake Non-Clinkering Furnace Block Co., Inc., as part of the Ernest E. Lee Co. exhibit showed for the first time the Finn block bolted-on construction to provide an all-metal exposure between bare tubes. This company also featured the new BTU suspended air-cooled wall available both with the fire-clay and with a silicon carbide veneered face, as well as the new line of BTU cements. A Carbofrax veneered suspended arch construction suitable for any make of arch was exhibited by The Carborundum Co. and a new type of sectionalized suspended insulated wall with one-half the weight of a 22½ in. standard solid wall was exhibited by the M. H. Detrick Co. Construction of air-cooled walls made with Plibrico was demonstrated by Plibrico Jointless Firebrick Co. and the steel case setting offered by this company was illustrated by a number of large exhibits.

Application of Adamant cement in the construction of flat suspended arches for the purpose of retarding spalling was a feature of the exhibit of the Botfield Refractories Co. Methods of using and tools for installing Ramtite plastic furnace lining and the new 100-lb. package was demonstrated by the S. Obermayer Co. Production of refractories, methods of manufacture and research activities of the Harbison-Walker Refractories Co. was shown by motion pictures. In the booth of the LaClede-Christy Fire Clay Products Co. several new and special mixtures were featured and the products of the John L. Cummings Co., recently associated with the LaClede-Christy Fire Clay Products Co., were exhibited to show the complete range of the combined products of the two companies.

Water Treatment and Heating

Continuous blowdown systems and their use with or without the Elgin system of deconcentration was demonstrated by the Elgin Softener Corp. by means of a small electrically-operated glass boiler model. Continuous blowdown systems were also featured by the National Aluminate Corp. with particular attention to their new variable orifice control recently developed to eliminate excessive valve maintenance and to give better control of the blowdown from individual boilers. A new line of vent condensers in small sizes for feedwater heaters were exhibited by the Power Plant Specialty Co.; a meter control device for chemical control on hot process softeners was exhibited by the Graver Tank & Mfg. Corp., and the new type of Electro-Chemical feeder or proportioner with a swing draw-off was shown by the Permutit Co. for the first time.

Valves, Traps and Packings

One of the interesting features of the show was the large number of high pressure steel and alloy valves offered. The William Powell Co. featured the new Cutler-Hammer motor control and exhibited many special alloy valves, among them a complete new line of aluminum alloy valves. This line includes aluminum elbows, tees, caps, couplings and unions in sizes from ¼ to 10 in. Lunkenheimer Co. exhibited a complete line of steel gate valves; Jenkins Bros. a new line of bronze valves with one-piece screw-over bonnet and slip-on stay-on disc holder and the Henry Vogt Machine Co. featured a new De Florez control for remote control of valves and a line of 600 lb. drop forged stainless steel globe valves made in ¾ to 6 in. sizes.

Many new special service valves were on display. Atwood & Morrill Co. exhibited their new oil closing type bleeder valve; the Cochrane Corp. showed a cut-away section of the new motor operated Multiport back pressure valve with the inverted dashpot; the Schutte & Koerting Co. exhibited their type F2 electric control, Venturi reducing valves and the hydraulically operated Wenig spool balanced reducing valve. The new type all ball-bearing stuffing box was a feature of The Fisher Governor Co., Inc., exhibit. This stuffing box has been adapted as standard for all Fisher liquid level controllers and rotary bonnet lever valves. They also exhibited their new pilot control unit utilizing a Bourdon tube and designed to eliminate draphragms in connection with pressure regulating valves. Yarnall-Waring Co. also exhibited the new line of Yarway Seatless and double tightening Blow-off valves.

Application of electric motors to special valve control was shown by the Bodine Electric Co. and an air pressure regulating valve of the piston type was exhibited by the Hannifin Mfg. Co. The Barco Mfg. Co. featured the Barco Lubricated Curb Cocks for underground gas service of air, water, gas or gasoline, and the Davis Regulator Co. featured their turbine bleeder non-return valve with an auxiliary oil cylinder, a new pressure regulater, constant pressure pump governor and a duplex balanced solenoid valve.

The Crane Co. featured their alloy steel valve and special alloy. The Central Valve Mfg. Co. exhibited two new valves, the Perfection, a self-grinding valve, especially adapted for conditions where scale, sediment and other solid matter is contained in the fluid being handled and the Replate, a globe and angle valve, designed for severe service in air, gas, oil, water or steam. The head of the valve is of special construction, and can be renewed or replaced as desired with any material most suitable for the purpose.

Button-Hole tape, a new development of the Garlock Packing Company, was exhibited and demonstrated in their booth. This is made up of two parallel courses of folded asbestos cloth jointed together by a single ply of bonding fabric. Another new packing material, Plasket, available in three grades for uses in steam, water, air, gas, brine, ammonia and petroleum products, was offered by the A. & E. Company. The Perfect oil retainer for shaft packing built in sizes from ½ to 12 in. was shown in a number of different services by the Chicago Rawhide Mfg. Co.

Traps, some for pressures as high as 1800 lb., were exhibited in new designs. One of the high pressure designs was the new piston operated, high capacity trap of the Armstrong Machine Wks., in the Barrett-Christie Co. exhibit. Another was a high pressure model of the Cochrane Corp. high capacity trainer. The Curtis Type T return trap, the bulb type thermostatic regulator and the Curtis excess pump governor which uses no packing were all features of the Julian d'Este Co. display.

Sarco Co., Inc., made a feature of the new Type TR-24 dead end service regulator and the heavy duty No. 9-4 steam traps. Kaye and MacDonald, Inc., offered two new traps, the K-Master, an inverted bucket trap, and the K. & M. Safety trap with the valve on the inlet and so designed that it will work even with the cover removed.

Alloys, Joints, Piping and Insulation

Various types of nickel alloy and monel metal were shown by the International Nickel Co. by means of products made by different companies who make use of these nickel alloys. The Babcock & Wilcox Tube Co. shows a number of Nirosta K-A-2 seamless tubes and pipe and the American Brass Co. featured Everdur & Mfg. Co. featured the new Savall rock wool pipe insulation suitable for high temperatures and supplied in 36-in. sections make up for different pipe sizes and thicknesses.

Unit Heaters and Heating Equipment

L. J. Wing Mfg. Co. exhibited a new 300-lb. unit heater with hairpin tubes connected to a steel header by mechanical joints and featured the Scruplex Saf-te fan guards, now a special feature of their heaters. A new concealed radiator was exhibited by the C. A. Dunham Co. and a new line of unit heaters in colors, designed particularly for office service, was exhibited for the first time by the Perfex Corp. The Powers Regulator Co. offered a new self-contained thermostatically controlled

metal, a copper-silicon-manganese alloy with corrosion and resistance properties. Sumet Corp. featured their new Thermo-Electric babbit metal, a number of bars of which were turned through an angle of 180 deg. to demonstrate its unusual properties. Universal Bearing Metals Corp. demonstrated the non-seizing, non-scoring properties of Bearium metal and Arthur Harris & Co. announced and exhibited a new line of permanent mold cast bronze bushings and aluminum bronze castings.

Croll-Reynolds Engineering Co., Inc., featured their FlexoDisc Expansion joints made up of flexible heat-treated alloy steel elements; Kopperman & Sons featured a new expansion joint with a special monel metal sleeve; and E. B. Badger & Sons Co. exhibited their vertical riser expansion joint.

Welded and seamless piping was shown by a number of exhibiters. Himelblau, Agazim & Co. had an exhibit of products from the new welding shop featuring the use of Tube-Turns; Geo. B. Limbert & Co. exhibited pipe bends and made special features of a new special 1500-lb. joint made for the American Power Piping Co. and a new line of Van Stoned joints for ½ in. pipe. A section of 24-in. seamless tubing was exhibited by the National Tube Co. along with sections of their copper-bearing pipe, a special rust resisting metal. General Insulating radiator valve and the Barber Coleman Co. has a new design of motor-operated controller for blast heater dampers, as well as new 5 and 6-in. motor-operated valves. Webster Tallmadge, Inc., featured heat zoning system with orifice distribution and electrically remote control while the Jas. P. Marsh & Co. showed a working exhibit of their differential vacuum heating system. Zone control systems and a new pressure actuated unit heater fan switch to cut the heater fan out of and in service with the steam supply to the heater were demonstrated by working equipment by the Illinois Engineering Co. The Mason hydraulic regulator connected for operation of under air pressure was shown by the Mason Regulator Co. operating a number of valves.

Power Transmission Equipment

Roller bearing application for heavy duty service such as steel mills, roll neck and locomotive service was featured by the Timken Roller Bearing Co., particular attention being paid to the new Timken 4-8-4 type locomotive, the first anti-friction locomotive built. The Fafnir Bearing Co. exhibited their J type Felt-seal bearing, designed to be dust proof under its own housing, particularly adapted for small portable tools. The Felt-seal line of bearings and the new pressed steel retainer

rings and thrust bearings designed to give the full complement of balls with a sturdy rugged construction was displayed by the Strom Bearings Co., and the Grea-Seal felt-protected ball bearings was displayed by the Norma-Hoffman Bearings Corp. Ahlberg Bearing Co. exhibited a new CJB self-lining bearing with white metal retaining ring and featured the new E-C (extended cone) pillow block. S.K.F. Industries, Inc., featured a new universal solid pillow block for heavy loads and high speeds and a unit pillow block known as the BX series. Rollway Bearing Co., Inc., demonstrated by means of a full-sized crane head their new maximum floating type bearing while the Shafer Bearing Co. exhibited self-aligning all roller bearing pillow blocks.

High speed chain drives with speed up to 4000 ft. per min. by means of forced feed lubrication was shown in service in the booth of the Boston Gear Works Sales Co. and the action of chain drives at high speeds were shown by the Morse Chain Co. by means of a Neon lamp synchronized with the pitch travel of the chain. A somewhat similar machine was used by J. E. Rhoads & Sons to show the relative efficiency of flat leather belting compared with other belting such as rubber and stitched canvas. The machine was equipped with a prony brake and a device to indicate the slip directly. High efficiency worm gearing for industrial service was featured by The Cleveland Worm & Gear Co.

The recently announced P. I. V. gear for variable speed transmission was the central figure of the Link-Belt Co. exhibit and the Reeves Pulley Co. made a feature of their new enclosed Reeves variable speed transmission built for vertical or horizontal operation up to 25 hp. The central exhibit of the Stephens-Adamson Mfg. Co. booth was the new motorized JFS variable speed reducer combined with an electric motor of standard manufacture. The unit is entirely self-contained so that the entire drive can be mounted with four base bolts and without a base plate. In addition to the improved Armorclad circuit breaker equipment, Type M centrifugal pump and the Type ARZZ explosion-proof motors exhibited by the Allis-Chalmers Mfg. Co., the Rossman System of adjustable speed control was a feature of the exhibit. With this system the stator of the driving motor is rotated by a second speed control motor to give close regulation of the speed of the driving motor. New applications of Fast's self-aligning couplings were shown by the Bartlett Hayward Co.

Tools and Instruments

Portable and stationary indicating pyrometers particularly designed for flue gas and stack temperatures were demonstrated by the Illinois Testing Laboratories, Inc. Steel instruments panels with enclosed wiring, new model control pyrometer with a mercury contacting switch having a capacity of 50 amperes at 220 v. was featured by the Republic Flow Meters Co. A flush mounted pyrometer, Model 425 built with a dust and moisture proof casing, differential level gage for surge tanks and a combined barometer and vacuum gage was featured by The Bristol Co. Flow meters for 2500 and 5000 lb. pressures were exhibited by the Foxboro Co. and the Vortex principle boiler feedwater meter was shown in operation by the Henszey De-Concentrator Co.

The Permutit Co. exhibited the new design of Ranarex CO_2 indicator and recorder with Bakelite impellers and a round recording chart. A number of new instruments were exhibited by The Hays Corp., among them a differential draft gage designed primarily for air filter service, new combined draft CO_2 and flue gas temperature indicating panel and a low CO_2 flasher which automatically calls the engineer's attention by flashing a light when the CO_2 drops below 8 per cent. Smoke indicating recording apparatus as it would be in a power plant and a recording condenser leakage or evaporator carryover meter calibrated to read percentage of leakage were two features of the Leeds & Northrup Co.'s exhibit. A power type pressure transmitter utilizing Selsyn motors and test water cooling coils for obtaining boiling water samples were exhibited by the Bailey Meter Co. Cooling coils of various types and sizes were also a feature of Parker Appliance Co. exhibit. The Duragauge, a new gage for pressures up to 10,000 lb. and made with an indestructible movement of Nitralloy steel was shown by the Consolidated Ashcroft-Hancock Co., Inc., and a new high pressure gage with a forge steel movement and a Duco dial was featured by the Crosby Steam Gage & Valve Co.

Portable testing equipment for tests of welded specimens was shown in operation in the booth of The Linde Air Products Co. and the new combination Type W 17 welding blowpipe was exhibited. One of the features of the Weston Electrical Instrument Corp. was the Model 551 Watthour meter circuit test set. Other instruments exhibited were the new Model 575 volt-ammeter watt meter and a new DC volt-ammeter, Model 540 with all circuits fused.

Application and use of the Brown motion transmitter and position indicator to show the position of valves, dampers, tank levels, and similar services, etc., at one or a number of points simultaneously, was demonstrated by the Brown Instrument Co. The Yorkco brine testing set for the pH value by the color method was exhibited by the York Ice Machinery Corp.

Tools

New tools for refacing Diesel engine exhaust valves and seats were demonstrated by The Leavitt Machine Co. This is a portable device made from 3 to 10 in. sizes. The Walworth Co. demonstrated the ease of operation of their new drop forged, all forged pipe wrench and the Snap-On Tools, Inc., featured their new Model 73 Giant Ratchet wrench for heavy work. Special high speed, 180 cycle motors for machine tool drive were exhibited in action with representative Black & Decker Mfg. Co.-Van Dorn machines and a new heavy duty double ended buffer with each end independent of the other but driven by the same motor was one of the features of the exhibit. Clements Mfg. Co. showed the improved Cadillac blower and demonstrated new applications. The Breuer Electric Mfg. Co. exhibited the improved Tornado portable electric blower and heat blowers and also demonstrated practical industrial application. The new Badger No. 4 car mover with cast steel shoe was shown for the first time by the Advance Car Mover Co.

In the only prime mover exhibit at the show, the Superior Engine Company showed two of their new designs, one 210 hp. 600 r.p.m., 8½x11 in. 12,500 lb. en-

gine and a small 33 kw. generator set. A new design in oil pressure filter especially designed for internal combustion engines was exhibited by the Wm. W. Nugent & Co., Inc., in sizes to handle from 150 to 4000 g.p.h. The Texas Co. had a gear mechanism to indicate the application of certain of their products and the Standard Oil Co. exhibited lubricants for use in all types of power plant equipment.

General purpose low head room crane for a.c. and d.c. operation from ¼ to 5 t. capacity, a new line, was shown by the Wright Mfg. Co. Two designs of compact hoists, one of the close clearance type equipped with new design of motor-driven trolleys were shown in operation by the Shepard Niles Crane & Hoist Corp.

A direct, positive counterflow heat exchanger with split tube sheet and floating head construction formed the central part of the Foster Wheeler Corp. exhibit. Practical application of condenser and oil cooler cleaning as practiced in power plant was shown in a large exhibit of the Oakite Products, Inc.

Irving Iron Works Co. exhibited a new radial grating for circular walkways and platforms around tanks, vats and stacks, and also demonstrated their stream line splice with which the flooring can be made continuous in both directions.

A full size Multumite Cubicle of all welded steel construction incorporating new overload protection features for across the line starting, dual overload feature, male and female disconnects and fully enclose air circuit breakers was exhibited by the I-T-E Circuit Breaker Co.

Jennings Suction pump, an open impeller centrifugal for sump service and the non-clog type for pumping waste, sewage, trash or any fluids containing a large percentage of solids, was the main feature of the Nash Engineering Co.'s exhibit. The Weil Pump Co. showed a new horizontal Type HCN non-clogging screenless centrifugal pump and the Economy Pumping Machinery Co. exhibited a new small 200-lb. pressure pump with a capacity of from 10 to 120 g.p.m. A modification of this design is supplied for pressures up to 400 lb. per sq. in.

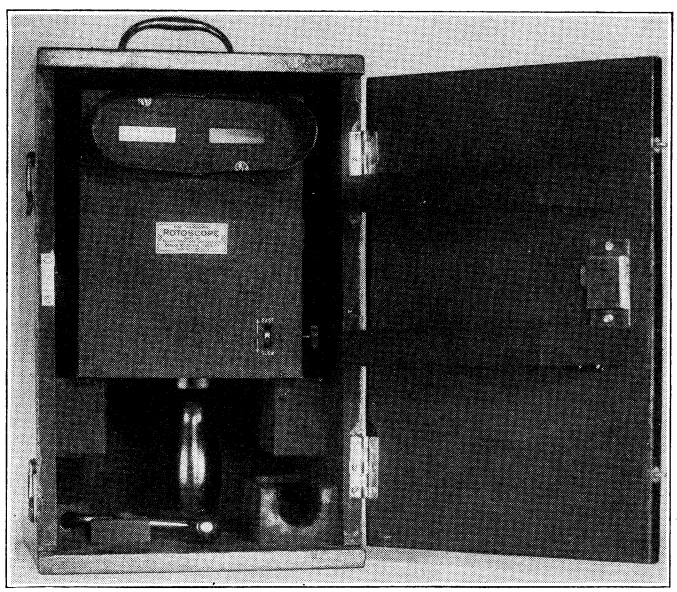
The Compact, a new type air filter in an extremely compact design, was the feature of the Independent Air Filter Co.'s exhibit and the American Air Filter Co. demonstrated a new window filter and ventilator. The Centrifix Corp. exhibited steam purifiers for steam, gas, vapor, compressed air, evaporating units and similar equipment.

The Swartwout Co. featured their new Carborator Type desuperheater and governor which taken in combination with their pressure reducing valve forms a complete reducing and desuperheating system for reducing high temperature high pressure steam to low temperature low pressure steam. Colvulc, a plastic rubber compound for repairing and preserving conveyor belts, lining for hoppers and chutes, covering for pipes, unions and valves, was demonstrated by The Hitchcock Co., Inc., in two forms, a corrosion resisting and abrasion resisting mixture. Johns-Manville Corp. exhibited for the first time a new asphalt block designed for surfacing roadways and platforms and particularly adapted to industrial practice. Two new soundproof materials for walls and floors, Absorbit and Absorbophone, were shown by the Korfund Co., Inc.

Rotoscope for Measuring Speed

ASHDOWN ROTOSCOPE is an instrument operating on the stroboscopic principle, by means of which the observer's vision is "geared up" to the speed of any rapidly moving object. It is designed so that periodic motion, whether rotary, oscillatory, vibratory or reciprocating, can be observed and studied and the exact speed of the moving object can be determined without physical contact of any kind with the object. Slow motion study and exact timing at any speed from 100 to 40,000 movements per minute can be accomplished.

Chief feature of the rotoscope is the rotary cylindrical shutter which is claimed to be capable of giving as many as a thousand glimpses per second, which blend into a continuous impression on the retina of the eye.



ASHDOWN ROTOSCOPE IN CARRYING CASE

The speed of this shutter can be varied by rapid adjustments with a tiny five-speed gear box. Fine adjustment speed control is secured by a special centrifugal governor, achieving an accuracy claimed to be well within 0.5 per cent.

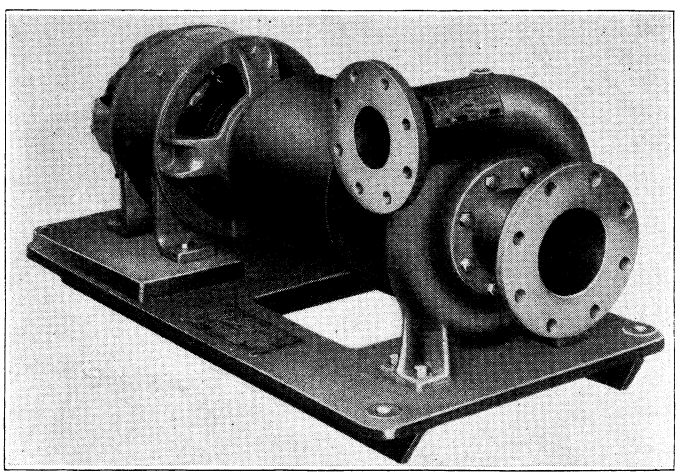
The instrument weighs six pounds. It is designed to make readings under practically any working conditions and without the aid of special illumination. It is operated by clock work and requires no electrical connections. The operator holds the instrument in his left hand with the shutter apertures to his eyes and controls the speeds with his right hand. By setting the speed of the shutter at exactly the speed of the moving object, the latter appears to be absolutely stationary. Its speed can then be read on the side of the instrument. By increasing or decreasing the shutter speed slightly, slow motion study can be achieved. Its applications in industry are stated to include the study and timing of gears, ball and roller bearings, springs, cams, valves, chain and belt drives, grinding wheels, bobbins, spindles, high-speed tools—without dangerous or undesirable contacts. It is used for purposes of synchronization; for the determination of speed losses from friction or slip; for the observation of vibration and deflection; in fact,

for the detection and elimination of the many mechanical troubles which hinder rapid production. The Rotoscope is made in England and distributed in this country by Livingston & Southard, Inc., New York City.

Fitz Auxiliary Hydroelectric Generator Unit

ALONG RURAL distribution lines, we often find but four or five customers per mile at low and intermediate voltages. When such lines run into any length, the voltage drop is large as the copper is rather meager. To correct the power factor on such lines means increased capacity on account of the reduced wattless component without an increase in copper.

For this service, the Fitz Water Wheel Co. of Hanover, Pa., has recently brought out a combined water turbine direct connected generator unit for the excita-



SMALL HYDROELECTRIC UNIT TO SUPPLY EXCITATION FOR SYNCHRONOUS CONDENSERS

tion of synchronous condensers, so that no current is taken from the line for excitation. Not much of a water power is required for such service, in fact the excitation for a 100-kw. synchronous condenser only amounts to about 3 kw. In most cases, the power companies have acquired the water and power rights of such streams along their lines, therefore these can be turned to good account and such corrective plants run by remote control, requiring only weekly attention as all lubrication is entirely sufficient for such intervals.

The illustration shows the construction on a common baseplate, rigidly tying the two members together. The regulation is by a built-in governor of high inherent damping so that even if 90 per cent load were suddenly thrown off the governing device would preserve practically constant speed, making but one or at most two corrective movements in bringing the water supply to the rate required for the new load condition. The speed adjusting is done at the factory under test load and the governor device then sealed to prevent tampering by unauthorized persons. When very close regulation of excitation voltage is required, the company supplies a reasonably priced voltage regulator for that purpose. The governing is water-saving in its functioning, although where irrigation rights or other matters prohibit this governing, electrical regulation is supplied which does not appreciably change the rate of water flow.

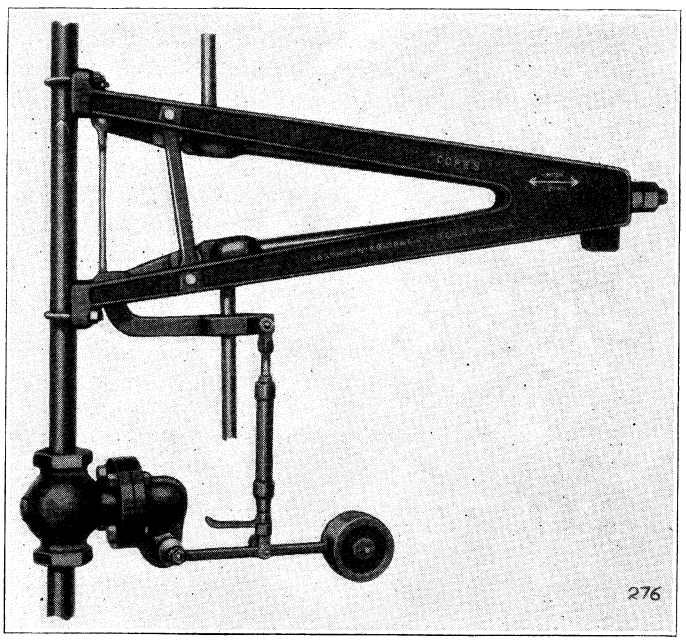
Shop tests indicate high efficiencies. Every unit gets a thorough shop test with ample overload to prove the set up and the insulation.

For isolated plants up to 20 kw., this combined water turbine-generator unit is ideal. No attention is required and the built-in governor avoids all trouble due to wide variations in voltage. As the turbine has but one moving part, the runner, it will be seen that it is as simple as it can be made.

Type OT Feedwater Regulator

DEVELOPED PRIMARILY for installation on oil field, horizontal return tubular, Scotch marine and similar types of boilers, the Copes Type OT feedwater regulator has recently been placed on the market. It consists, as shown, of a balanced valve actuated by air expansion tube or thermostat. The valve is the standard Copes regulator valve, type BI with horizontal rotating lever shaft, used in place of the usual sliding stem to reduce friction.

Type OT thermostat is made up of two short tubes connected at an angle by a heavy bronze return bend. Both tubes are in tension and give the operating effect of a single tube. The thermostat is connected to the boiler in the same manner as a water column. Steam fills the upper part of the tube and water the lower



TYPE OT COPES REGULATOR WITH VALVE IN VERTICAL FEED LINE

part and as the water level falls and rises, the increase or decrease of steam causes the tube to expand or contract, actuating the valve to close as water level rises and open as it falls.

The valve can be installed in the vertical feedwater line, to which the thermostat is clamped as shown; if the valve is placed in a horizontal line, the thermostat can be supported on special pipe fittings placed on the horizontal line. The new regulator is a product of Northern Equipment Co.. Erie, Pa.

Oil Burner Control System

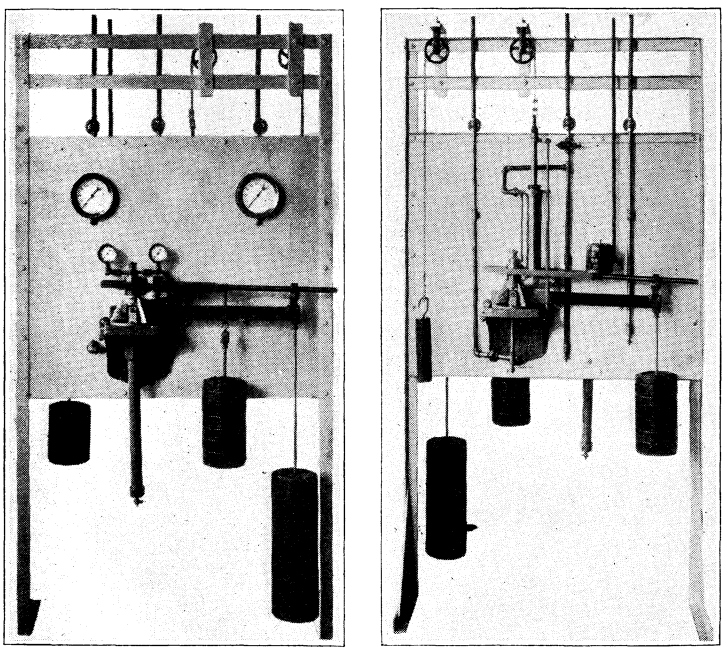
RECENTLY DEVELOPED system of regulation for the control of oil feed is shown in the accompanying photographs. The unit shown was recently installed in a large hospital in Brooklyn, N. Y. This particular unit consists of a panel containing a master steam regulator mounted on one side of the panel and a Victor pressure regulator on the other side. The photographs show both sides of the same panel. The units are so mounted that the master steam regulator has control over the oil or pressure regulator by actuating a pinion which is clearly visible in the photograph. Two pinions, mounted on a horizontal shaft, engage the compensating rack on both regulators; that is, there is a pinion on each end of the shaft as shown in the photographs.

This combination has been developed for varying the oil pressure in any desired ratio with changes in the steam pressure, the regulation being accomplished either by controlling the speed of a steam driven oil pump or by the control of an oil discharge line relief valve where a constant speed electric pump is used. The regulators are hydraulically operated, employing city water pressure as the medium of operation. They are claimed to be extremely sensitive and consequently accurate within a small fraction of a pound.

It will be seen that on an increase in steam pressure, it may be desired to decrease the oil pressure immediatly and, as explained above, this may be accomplished in any ratio or range.

The racks, upon pressure changes, travel in opposite directions. Thus, while the rack on the master steam regulator travels outward, adding additional weight to compensate for an increased pressure, the rack on the oil or pressure regulator travels inward, in the opposite direction. The result is that the adjusting weights travel back toward the fulcrum, thus reducing the pressure at which the regulator will actuate the pump governing valve.

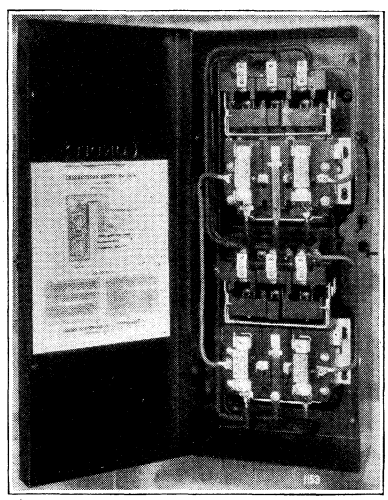
This system can be extended, it is stated, by adding thereto one additional pressure regulator, to make the system applicable for controlling, through the master steam regulator, the steam atomizing type of oil burner. One of the pressure regulators would actuate a governing valve and would have control of the steam pressure to the burners, while the second unit would control the oil pressure. While the steam and oil pressure regulators would, through changes in the boiler pressure, be controlled by the master regulator, each may be independently adjusted to maintain any predetermined ratio that may be required for proper atomization. The regulating valves are manufactured by The Atlas Valve Co., Newark, N. J.



CONTROL FOR OIL BURNER, SHOWING MASTER STEAM REGULATOR, LEFT, ON ONE SIDE OF PANEL, ACTUATING PRESSURE REGULATOR, RIGHT, ON OTHER SIDE THROUGH TWO PINIONS ON HORIZONTAL SHAFT

Motor Starter

CONDIT ELECTRICAL MFG. CORP., Boston, Mass., announces a new reversing cross-the-line air motor starter for the control and protection of squirrel cage induction motors. The starter, known as type A-30-R, consists of two of the type A-30 arc prevention motor starters mounted in a sturdy enclosing case and mechanically interlocked so that only one starter can be in closed position at one time. Both starters are equipped with thermal relays for time lag overload protection. The starters are furnished for push button control up to 20 hp., 550 and 440 v.; 15 hp., 220 v. and 7½ hp., 110 v.

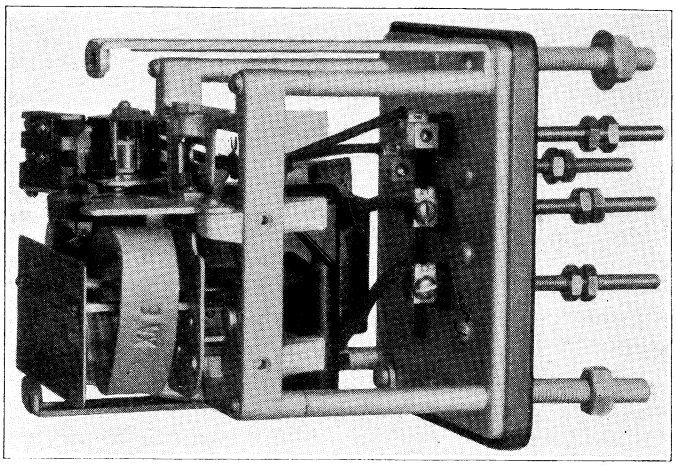


TYPE A-30-R AIR MOTOR STARTER

USUAL CYLINDER RATIOS in compound Corliss engines increase with the pressure and are higher for condensing than for noncondensing service. Typical values for noncondensing service range from 1 to 2 at 100 lb. steam pressure to 1 to 2.75 at 175 lb. steam pressure, and for condensing service from 1 to 3 to 1 to 4.5 for the same pressure range.

New Induction Undervoltage Relay

GENERAL ELECTRIC CO. has just announced a new induction relay, designated Type IAV, for undervoltage protection of alternating-current circuits. It is a single-pole, single-circuit device and has circuit-closing contacts. It is applicable to circuits of 600 v. or less and to circuits of higher voltages with the 110-v. secondaries of potential transformers. It is available for 25 and 60-cycle service.



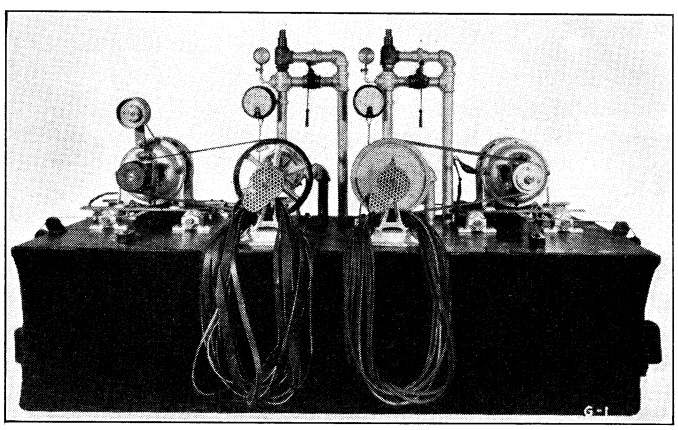
VIEW OF THE RELAY REMOVED FROM THE CASE SHOWING INTERIOR CONSTRUCTION

This new relay has a universal design of rectangular case which harmonizes with switchboard instruments and meters which are now standardized with similar cases. It is only 5½ in. wide. Four such relays may be mounted side by side on a panel 24 in. wide. A glass front and light finish of certain parts permit ready inspection.

All contacts are self-alining, the stationary member being individually adjustable and the movable member a silver disc which provides different points of contact. When the relay has operated, a target indicator is visible from any front angle.

Belt Pull Comparison

TWO IDENTICAL pumps and two identical motors made up the demonstrating apparatus, illustrated, which has attracted much attention at recent exhibits of E. F. Houghton & Co., to compare the pulling power of flat leather belting and of rubber V-belting. When the by-pass valves were closed the positive pumps developed a pressure against spring check valves, the load being graduated up to 5 hp.



ARRANGEMENT OF DEMONSTRATION EQUIPMENT

Every condition, tensions, pulley diameters, speeds were as nearly the same as physically possible. Demonstrators offered to interchange the sheaves and pulleys whenever desired and permitted visitors to operate the exhibit themselves in any way they pleased to convince themselves that the demonstration was not fraudulent.

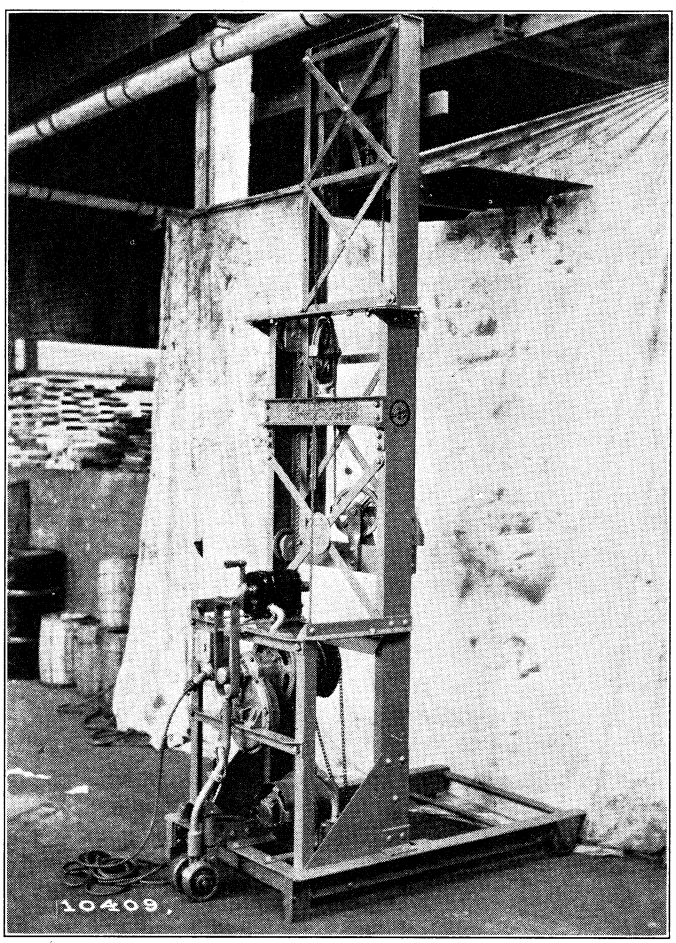
Flat leather belt of 2 hp. capacity was compared with two strands of rubber V-belting. The flat Vim belt is stated to have pulled full capacity load, while the V belt drive is stated to have pulled only 3 hp. and then with from 25 to 100 r.p.m. slippage on the pump sheave.

New Portable Lifts

BALL-BEARING equipped lifting machines, both hand and power operated, plain and telescoping, are a new development, the machine shown being an electric telescoper.

Ball-bearings are used throughout the gearing and in the sheave and platform frame wheels, also on the telescopers for the sliding frame wheels. By these and flangeless guide wheels to support the platform and telescoping frames, 25 per cent increase in efficiency is obtained.

Spur geared hoisting units are used exclusively, that of the hand power being fully guarded and lubricated



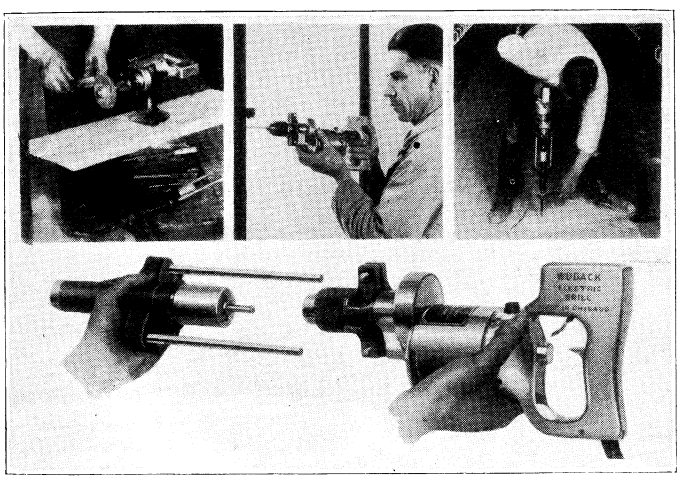
NEW ELECTRICALLY OPERATED TELESCOPER

with grease. The electric unit is contained in a metal case and runs in a bath of oil. The former has a self-acting gravity brake while the latter has a dual system, both brakes working automatically to hold the load wherever desired and prevent falling of the platform in case of current failure.

All motors are controlled, unless otherwise specified, by a single lever drum switch, while a lever attached to the rear of the controller shaft operates the service brake. Automatic limit stops by return control lever to "stop" position to prevent overtravel of the platform, thereby stopping the motor and setting the brake. These lifts are made by Economy Engineering Co. of Chicago, Ill.

Dual Twist and Hammer Drill

ELECTRIC hand drill designed to work with equal facility in wood, metal and masonry, known as the Wodack electric dual twist and hammer drill, has recently been developed. It is designed to operate both as a hammer and as a rotary drill, with capacity up to 3/8 in. in metal, 1/2 in. in wood and 7/8 in. in stone, concrete or brick. It is furnished in a metal carrying case, with star drills and twist drills. Grinding, scratching and buffing wheels and bench stand can be supplied, as



VIEWS OF TWIST AND HAMMER DRILL IN USE

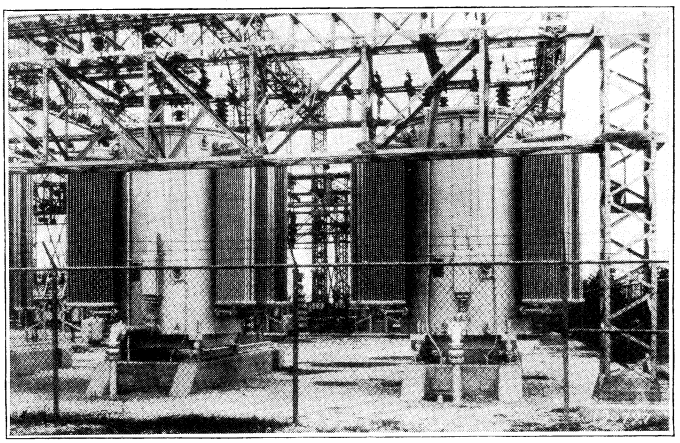
well as a stand for use as an auxiliary drill press or bench grinder. The tool weighs 12 lb. and the entire kit 20 lb. The tool is made by Wodack Electric Tool Corp., Chicago, Ill.

"Double Minded" Transformers

TRANSFORMERS OPERATING in parallel have a "mind of their own" in that they divide the load in proportion to their per cent impedance and stubbornly refuse to alter this load division.

Two large Westinghouse power transformers recently shipped to the Gulf State Utilities Co. are designed with two different inherent reactances, or "double minds," to be adjusted for either reactance at the will of the operator.

The transformers are rated at 9383 kv-a., 1 phase, 60 cycles, 66 kv. high voltage, 13.2 kv. low voltage. The high voltage winding has a parallel connection for 33 kv. They will be operated with 66/33/13.2 kv. three-



VIEW SHOWING INERTAIRE EQUIPMENT OF THE 9383 KV.-A. SELF-COOLED TWO-WINDING TRANSFORMERS WITH DOUBLE IMPEDANCES

winding transformers now installed. When the new transformers are operating with the 66/13.2 kv. windings of the old bank, the impedance is 7.8 per cent. When operating with the 33/13.2 kv. windings, the impedance is 6.5 per cent.

The change in impedance is obtained by an arrangement of the 13.2-kv. winding, which, according to Westinghouse engineers, changes the length of the path of the flux which produces reactance, as well as its intensity, and depends only upon the connections made in the l.v. winding. No reactors or auxiliary windings with circulating currents are used.

News Notes

J. ROY TANNER, since 1911 vice-president and general manager of the Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, has been elected president of that company succeeding C. A. Anderson, Jr., who has severed his connection with the organization. Mr. Tanner entered the employ of the Pittsburgh company in 1901, following attendance at the University of Pittsburgh. He served as chief engineer until 1911, when he became vice-president and general manager. Mr. Tanner is a member of the American Society of Mechanical Engineers and the Engineers Society of Western Pennsylvania. George J. Stuart has been appointed vice-president and a director of the same company. He is a graduate of Pennsylvania State College and became identified with the Pittsburgh company in 1901. He served for a time as draftsman and later as assistant chief engineer, succeeding Mr. Tanner as chief engineer in 1911. Four years ago he was made manager of production. Mr. Stuart is a member of the American Society of Mechanical Engineers, the American Society for Testing Materials and the Engineers Society of Western Pennsylvania.

HAHN ENGINEERING CO., has moved its main office from Easton, Pa., to 30 Church St., New York City. Eugene Hahn is in charge at the above address.

BAILEY METER CO., Cleveland Ohio, announces the appointment of P. S. Dickey as research engineer. Mr. Dickey is a graduate in mechanical engineering of Purdue University, and during the past few years has been specializing on automatic combustion control problems for the Bailey Meter Co.

FIFTY-FIVE representatives of the Barber-Greene Co., in the United States and Canada gathered at the company's plant at Aurora, Ill., January 8-10, for the annual Barber-Greene sales conference. The meeting took the form of an instruction course with class room lectures and laboratory work. In the class room the men were addressed by H. H. Barber and W. B. Greene, president and vice president, and by other officers of the company, who outlined the policies and methods of the home plant. Guests of honor who addressed the assembly were J. W. O'Keefe, secretary of the Chicago Association of Credit Men; H. J. Fauber, president of the Central West Engineers, Inc., of St. Louis, a company that has laid extensive pipe lines throughout Illinois, Indiana, and Missouri; and Mike Andrews, foreman second in charge of the con-

creting by conveyor of the Marshall Field Merchandise Mart, and more recently in charge of the same operations on the three million dollar American Can Co. building in Chicago.

YEOMANS BROTHERS Co., Chicago, Ill., announces the appointment of the Jackson Engineering Co., 934 Architects and Builders Building, Indianapolis, Ind., as its representative in that territory.

ARTHUR E. JONES Co., 417 S. A. & K. Bldg., Syracuse, N. Y., has been appointed sales representative for Diamond Power Specialty Corp. in the Syracuse district.

H. W. FOULDS, assistant to the president, has been placed in general charge of all sales work, by Goulds Pumps, Inc., Seneca Falls, N. Y. Mr. Foulds was formerly connected with Servel, Inc., as vice-president.

CLAUS GREVE was elected chairman of the board and L. W. Greve and John DeMooy were named president and treasurer respectively of the Cleveland Pneumatic Tool Co., Cleveland, Ohio, at the annual meeting recently of the board of directors. H. W. Foster was reëlected vice-president, H. S. Covey was reëlected secretary and Arthur Scott was reëlected superintendent. A. F. Barner was named assistant secretary. All the directors, including S. G. Down of Pittsburgh, were reëlected. Those named above, excluding Barner, constitute the directorate.

WM. POWELL Co., Cincinnati, O., announces that Howard Butt has been made manager of the engineering and export department of the company, office 50 Church St., New York.

MODERN COAL BURNER Co., Chicago, Ill., announces that George F. Klein has accepted the distributorship for its product in Eastern Kansas, Eastern Nebraska, Western and Northern Missouri. The offices for this district are located at Room 432 Dwight Building, 1004 Baltimore Avenue, Kansas City, Mo.

Books and Catalogs

ARTIFICIAL SUNLIGHT, By M. Luckiesh, 254 pages, 6 by 9, 254 illustrations, cloth. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, 1930; price, $3.75.

It is a pleasure to welcome a book such as this to the literature of electrical illumination. Written by a man whose name for many years has been legion in the field of illumination and who, as director of the lighting research laboratory of the Edison Lamp Works and the National Lamp Works of the General Electric Co. has been actively engaged in the development of all kinds of lighting equipment, this book gives one a broad background of the fundamental physics and biology as well as the practical scientific details themselves. It fully covers the methods of radiation measurement, the character of radiation produced by different sources, and the properties of radiation of various wave lengths.

A book of this kind is valuable not only because of the immense amount of accurate data it contains on a subject on which heretofore little information has been available, but because of its destructive effect upon many fake ideas and concepts which arise in any new field. The ultra violet ray racket has been a good one and as a consequence there is in the hands of the ever-credulous public today, a vast amount of socalled ultra-violet light producing equipment, the efficacy of which at best is dubious. Anything that would produce a visible irritation of the skin was sold as a health lamp, and the public ran up heavy light bills trying to outdo each other in producing the most severe degree erythema (sunburn).

Now, it is known that natural sunlight possesses health-giving properties—few living things can exist without utilizing the benefits of solar radiation either directly or indirectly. It is also true that prolonged exposure to strong sunshine produces erythema. From this, however, it does not follow that any source of radiation which produces erythema is healthful or biologically beneficial, yet this in many instances has been the sole factor in the sale of much of this equipment. The beneficial effects of solar radiation are recognized but the mechanism involved is yet only imperfectly understood and even in a book so comprehensive as the present volume by Mr. Luckiesh, no pretense is made that knowledge of this subject is complete.

A great deal is known, however, and the reader who has not kept abreast of developments in this field, will find much of interest in this fascinating book. Many gaps still exist in our knowledge of the biological effects of radiation but the foundation appears to be sufficiently established to enable any ordinary intelligent person to acquire an excellent understanding of these effects.

The era of artificial sunlight has scarcely been started. Heretofore, we have had ultra violet lamps only in physicians' offices, in hospitals or laboratories and more recently we have had them in the home for health purposes only. There is every reason to believe, however, that the future of artificial sunlight lies not in its application in the laboratory but in the field of general illumination, in the home, in the office or in the factory.

In this book, the effects of radiant energy have been coordinated with the physics of the subject—a combination which is often incomplete in biological researches and in therapeutic practice. For this reason, the data and discussions should be helpful to physiologists, biologists, the medical profession and others primarily interested in health maintenance as well as to physicists, engineers and others interested primarily in lighting the indoor world.

DESIGNING HEATING AND VENTILATING SYSTEMS, by Charles A. Fuller. Third Edition, 244 pages, 5½ by 8¾ in.; 89 illustrations, 39 tables, cloth. Published by Scientific Book Corpn., 15 E. 26th St., New York, 1931; price, $3.00.

Beginning with the fundamentals of heat, work and their relations, the author treats of those factors of which an understanding is necessary in order to provide a satisfactory heating and ventilating plant for any kind of building. Heat loss from buildings, classes of heating system, details of each and the requirements for heating surface, piping systems and boiler plant are discussed with a minimum use of formulas, those used being of simple character. Steam, vapor, hot water, hot and warm air are considered. Air needed for ventilation and equipment and arrangement of the system to get good distribution are treated. One chapter deals with steam for hotel, laundry and process work; another with piping and auxiliaries for the boiler room. Presentation is clear; arrangement of the book is well planned; unessentials have been eliminated and the result is a condensed but complete and convenient manual on the subject treated.

WASHABILITY TESTS OF ILLINOIS COALS, by Alfred C. Callen and David R. Mitchell. This has just been issued as Bulletin No. 217, by the Engineering Experiment Station of the University of Illinois, Urbana, Ill.; 6 by 9 in., paper, 112 pages; price, $0.60.

Report of an investigation made on the washing characteristics of Illinois coals. The objects were: to study the occurrence of visible impurities in the coal; to study the methods of mining and determine what effect they had on the impurities in the mined coal; to consider the possibilities of hand picking these coals; to make a reasonably complete study of the washability of these coals; to determine the amount and distribution of ash and the different forms of sulphur; to determine yields of washed coal and the limits of the reduction of ash and sulphur percentages; to make some studies of the variation in fusion point of the ash of raw coal and washed coal. Seven mines in the state of Illinois were selected as representative and tests were conducted as described. The bulletin contains a report of each mine studied, giving a description of the mine, analyses of the samples of coal used, the test procedure, and the results of the washability tests. A limited number are available for free distribution by the Engineering Experiment Station, Urbana, Illinois.

THE MODERN STEAM TURBINE, by E. A. Kraft. Published by VDI-Verlag, G.M.B.H., Berlin, NW 7, Germany; 198 p.; 7½ by 10½ in.; cloth.

This book, written by the director of the A.E.G. Turbine Works in Berlin, fills the long felt need of the engineering public for a work which combines in a single volume the details of construction and design of all types of modern turbines. Turbines from twelve Continental, seven English and five American manufacturers are represented in the book. American machines receive their full share of attention, particularly in the chapters devoted to large turbines and condensers and auxiliaries.

Detailed theory, complicated formulas and equations have been omitted. The book is in fact a critical survey founded on practical experience and the turbine examples shown indicate the latest design tendencies. The first part of the book is a discussion of the methods pertaining to higher economy brought about by increasing heat drop and by improved turbine design and construction. The discussion is profusely illustrated by drawings showing actual design; each part such as glands, bearings, rotors and governors receiving individual attention. The second part deals with the technical factors limiting the design, that is, such as the characteristics of the metals used in construction and the method of testing these materials. The third section deals with the general principles of design and the fourth section shows the application of these principles to the actual design, high-pressure turbines, back-pressure turbines, extraction turbines, low-pressure turbines, mixed-pressure turbines and turbines for very high pressure receiving detailed treatment. The last section is devoted to condensers and auxiliaries.

This book is available both in German and English edition, the English translation being so well done and showing such keen appreciation of American practice that it would be impossible for the reader to determine the nationality of the author except by the frequent reference to the German publications, the use of metric units in the tables and the conversion of metric units to English units such as tons per square inch, which shows English rather than American influence.

THE TORSIONAL EFFECT OF TRANSVERSE BENDING LOADS ON CHANNEL BEAMS, by Fred B. Seely, William J. Putnam, William L. Schwalbe. Published as Bulletin No. 211, Engineering Experiment Station, University of Illinois, Urbana, Ill.; 63 p., 6 by 9 in., paper; price, $0.35.

Results of tests and analysis to determine where load should be applied to steel rolled channels to produce bending without twisting and also to determine the longitudinal stress in a channel beam if the channel is loaded so that twisting accompanies the bending. Six types of channels were tested and each tvpe of channel was tested as a horizontal cantilever beam with a vertical load applied at the end. A few copies of this bulletin are available for free distribution by the Engineering Experiment Station.

INDEX to A. S. T. M. Standards and Tentative Standards is a 93-p. booklet giving references to its Proceedings and published records where standards for materials, machinery and structures may be found, as well as methods for tests of materials. It is complete as of Sept., 1930. Copies will be furnished without charge on request to American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.

A NEW 16-PAGE, illustrated publication, identified as Circular 1686-A and entitled Micarta in the Central Station, has been announced by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. In the Power Station, Micarta has many applications, including: wall bushings, insulating bus cars and connections, strengthening and insulating cable joints, collector ring tubes, circuit-breaker terminal insulation, panels, cleats, and gears.

A NEW EDITION of "Registers of Revenue," an illustrated, 16-page circular describing watthour and demand meters, has been issued by the Westinghouse Electric and Manufacturing Co., Newark, N. J. This publication, which is identified as Circular 1753-B, includes for the first time a detailed description of the new Ob Detachable Watthour Meter, which can be mounted readily either outdoors or indoors to facilitate installation, reading, testing, and removal.

TYPE SSU CENTRIFUGAL PUMPING UNITS are described in bulletin No. 1647 by Allis-Chalmers Mfg. Co., Milwaukee, Wis. In these units the pumps and motors are designed as a complete assembly, all mounted on the same shaft without a coupling. They are designed for service where a small quantity of liquid is needed at heads up to 100 ft.

STRAINERS for oil, water, steam, are described and illustrated in color, accompanied by tables of dimensions, capacities and prices in bulletin No. 9-S recently issued by Schutte & Koerting Co., Philadelphia, Pa.

WHITING NO. 3 UNIT PULVERIZER in capacities from 30 to 800 lb. per hr. is described and illustrated in a recent bulletin No. 10 by Whiting Corp., Harvey, Illinois. Bulletin No. 9, issued by the same company, describes in detail the Grindle Multi-Stage Unit Pulverizer for capacities from 500 to 4000 lb. per hr. Burning Brick More Economically with Automatic Stokers, by Joseph Harrington, is issued by the company as bulletin No. H-64. The Whiting Stoker, formerly the King Coal Stoker, for power and heating use is described in a bulletin of the Joseph Harrington Co., subsidiary of Whiting Corporation, while another bulletin of the same organization discusses Burning Iowa Coal Successfully with Whiting Stokers, a practical test, by Joseph Harrington.

EXPERIENCES IN CHLORINATING CONDENSER circulating water by Vincent M. Frost and W. F. Rippe of the Kearney Station of Public Service Electric & Gas Co., Newark, is being issued as technical publication No. 112 by Wallace & Tiernan Products, Inc., Belleville, N. J. This describes the experiences at Kearney Station in endeavoring to better the heat transfer and reduce the cost of cleaning condensers by the use of chlorine gas in treating the circulating water.

DESCRIPTIONS and illustrations of the great variety of products manufactured and sold by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., are given in the new Westinghouse general catalog for 1931-32, a 1352 page bound book. This catalog presents complete data on distribution apparatus, switchgear, lighting equipment, domestic appliances, gearing and current-collecting devices, with condensed listings of industrial motors and control apparatus, industrial heating apparatus and commercial cooking equipment and description of other products. The new Visicode Supervisory Control, the De-ion circuit-breaker, and new types of panelboards and watthour meters and other recent development should be of particular interest to central stations. An interesting feature of the new catalog is the instant index, a two-page spread on heavy blue stock, in the center of the book. An illustrated introductory section presents a brief history of the Westinghouse Electric and Manufacturing Co. and a description of interesting research developments.

AUTOMATIC CONTROLLER VALVES, motor operated type, are fully described and illustrated in a 20-page bulletin published by the Bristol Co., Waterbury, Conn. In this catalog, No. 2002, attention is especially called to the latest development in the type BK control for steam, water, air and gas and the valve type BK for floating control. Other types of controllers are shown with details of the parts clearly illustrated and data are given on methods of applying the equipment. In catalog 4000 the company describes and illustrates various accessories for the air operated controller equipment.

NEW TYPE B PULVERIZER is described and illustrated in bulletin 5-80 recently issued by the Fuller Lehigh Co., Fullerton, Pa. Outstanding features of this mill include the spherical-ball and grinding ring principle of pulverizing in which fineness is not affected by wear of grinding parts and the enclosure of all parts requiring lubrication in dust and oil tight housings apart from the grinding zone. Method of obtaining pressure between the ball and grinding ring is illustrated and the parts are completely described and well illustrated.

BUYERS' GUIDE to Nickel Alloy Steel Products, a 16-page tabulation of sources of supply for the more commonly used forged, rolled cast or drawn products made from nickel steels and alloys is being issued by the International Nickel Co., Inc., 67 Wall Street, New York City.

TO ILLUSTRATE the application of the inductance bridge principle to modern flow metering, the Brown Instrument Co., Philadelphia, Pa., is issuing an interesting working model of a flow meter. This is incorporated in a card of about 3 by 5 in. in size and shows cross-section of the manometer mechanism of the flowmeter itself together with the armatures and instrument coils in an indicator and recorder. Upon moving a tab at the bottom of the card, the armature in the manometer moves up and down and its motion is followed exactly by the motion of the armatures in the instrument, causing the pointer of the indicating instrument to move over the indicator scale.

IRVING ENGINEERING DATA covering continuous steel flooring, Vizabledg Safsteps, Unified Bridge floor system and other equipment is presented in a recent bulletin by Irving Iron Works Company, Third and Creek Streets, Long Island City, N. Y.

NICHOLSON INDUSTRIAL STEAM TRAP for pressures from vacuum to 100 lb. for various industrial applications such as unit heaters, kitchen equipment, pipe coils, blast coils, dry kilns, dryers, and so on are described in a new bulletin No. 1030 by W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa.

ROTARY PUMPS for hydraulic service, for transfer of power and for circulating cooling solutions are fully illustrated and described in a new 104-page catalog just issued by Geo. D. Roper Corp., Rockford, Ill.

FAIRFIELD PORTABLE CONVEYORS and feeders for industrial service, for handling coal, sand, gravel and the like are described in Bulletin No. 35-1 by The Fairfield Engineering Co., Marion, Ohio.

WIRE ROPE PROBLEMS Confronting Elevator Designers, a paper by James F. Howe, wire rope engineer, read before the Elevator Manufacturers Association of the United States, is being distributed in bulletin form by American Steel & Wire Co., 208 So. La Salle St., Chicago, Ill.

VERTICAL TRIPLEX power pumps, their construction, application, capacities, dimensions, are described in a new 44-page illustrated catalog by Worthington Pump & Machinery Corp., 2 Park Ave., New York City.

TENTH ANNUAL REPORT of the Federal Power Commission for the fiscal year ended June 30, 1930, has been issued and can be obtained from the U. S. Government Printing Office, Washington, D. C.

HYDROJET APPLICATIONS are described in great detail, with many interesting illustrations, in Catalog No. 1230, a 24-page bulletin recently issued by Allen-Sherman-Hoff Co., Philadelphia, Pa. Details are given of the use of the hydrojet system of ash removal with stoker-fired furnaces, both underfeed with clinker grinders and chain grate types. Data on its use with pulverized coal-fired furnaces are given, both air-cooled and water-cooled furnace bottoms being treated, also the use of the system with slag tap furnaces. In another 40-page bulletin, Catalog No. 1130, the company discusses Hydrojet advantages. Storage and removal of ash, removal of molten ash, discharge of ash to sump or fill, pumping of ash and recirculation of water, pumping of ash to bin, sump or fill are some of the topics treated.

FUEL BURNING AND STEAM GENERATING EQUIPMENT are described in a new 16-page general condensed catalog GC-6 by Combustion Engineering Corp., 200 Madison Ave., New York City. Details are given of coal pulverizing and firing equipment, furnaces, stokers of several types, air preheaters, economizers, steam generators, boilers.

Power Plant Construction News

Ariz., Tucson—The Tucson Gas, Electric Light & Power Co., is planning extensions and improvements in steam-operated electric power plant, including installation of a new 15,300 hp. Diesel engine unit and auxiliary equipment, reported to cost more than $350,000.

Ark., Fort Smith—The Quix-Kold Corporation, Oklahoma City, Okla., has plans for a one-story dry ice-manufacturing plant, 50 x 100 ft., at Fort Smith, estimated to cost close to $60,000, with equipment.

Ark., Paragould—The Arkansas Utilities Co. will carry out an expansion and improvement program at local ice-manufacturing, including installation of additional equipment, reported to cost about $25,000.

Calif., Glendale—The City Council has authorized an appropriation of $121,000, for electric light and power department during 1931, including installation of power substation equipment at San Fernando and Grandview, to cost about $35,000; new transmission lines, line transformers and equipment, underground conduit, etc.

Calif., Palo Alto—The Board of City Trustees, Palo Alto, is said to be considering extensions in municipal power station. The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., have been engaged to prepare plans.

Calif., San Jose—The Drew Canning Co., San Jose, care of William F. James, San Jose, attorney, company representative, is planning installation of electric power equipment in proposed new fruit canning plant in vicinity of San Jose, entire project to cost over $80,000. F. M. Drew, Sunnyvale, Calif., is head.

Calif., San Mateo—The Board of City Trustees, San Mateo, has engaged the Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., engineer, to prepare a report and estimates regarding a proposed municipal electric light and power plant.

Conn., Hartford—The New England Electric Co., 103 Allyn Street, has approved plans for an equipment storage and distributing plant on local site to cost about $70,000.

Ga., Augusta—The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., has tentative plans under way for a power plant and distributing system at Augusta, for Paul M. Thayer, Augusta, and associates, holders of franchise, subject to the approval of the Augusta Canal Commission.

Ga., Thomson—The Thomson Light & Water Co. is said to have plans under way for extensions and improvements in power plant, including installation of a Diesel engine and accessory equipment.

Ill., Belleville—The Peerless Enameling & Stamping Co., Belleville, plans installation of electric power equipment in proposed new one-story plant addition, reported to cost over $75,000. R. G. Williams is secretary.

Ill., Kewanee—The Western Illinois Ice Co., Galesburg, Ill., has plans under way for a one-story ice-manufacturing plant at Kewanee, to cost about $65,000, with equipment. Westerlin & Campbell, 1113 Cornelia Avenue, Chicago, are architects and engineers.

Ind., Lafayette—The Board of Trustees, Purdue University, has plans nearing completion for a steam-operated power plant for institutional service, reported to cost about $100,000, with equipment. Walter Scholer, Wallace Building, Lafayette, is engineer.

Ky., Louisville—The Merchants Ice & Storage Co., 217 East Main Street, has plans under way for extensions and improvements in ice-manufacturing plant No. 2, including installation of additional equipment. The United Engineers & Constructors, Inc., 112 North Broad Street, Philadelphia, Pa., is engineer.

Md., Hagerstown—William A. Danzer & Co., Hagerstown, are said to be planning installation of electric power equipment, including motors, etc., in connection with proposed rebuilding of woodworking plant, recently destroyed by fire with loss reported over $100,000.

Mich., Hubbard Lake—The Hubbard Lake Resort Association, Hubbard Lake, is at the head of a project to construct a transmission and distributing system in the farm and resort district of Alcona County, totaling about 60 miles. Estimates of cost will soon be made.

N. J., Trenton—Green Brothers Co., Springfield, Mass., manufacturer of yeast, plan installation of electric power equipment, including motors, controls, etc., in proposed new plant at Trenton, where former factory of the Bergougnan Rubber Co., East State Street, has been secured, entire project reported to cost over $75,000.

Ohio, Lisbon—The Town Council is reported planning the installation of a municipal electric light and power plant. It is understood that estimates of cost will soon be made.

Ohio, Shelby—The City Council has secured a report from the Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., engineer, covering proposed extensions and improvements in municipal electric light and power plant, including installation of additional equipment, estimated to cost $220,000.

Ohio, Toledo—The Standard Oil Co. of Ohio, East Ohio Gas Building, Cleveland, plans installation of electric power equipment in proposed new asphalt plant at Toledo, entire project reported to cost over $500,000.

Okla., Fairfax—The City Council is said to be planning a public election to approve a bond issue of $120,000, for a municipal electric light and power plant.

Ore., Dallas—The Willamette Valley Lumber Co., Dallas, is reported planning an addition to electric power plant to cost about $75,000, with equipment.

Pa., Pottstown—City Council, Pottstown, is asking bids until Feb. 24, for a new pumping plant for municipal water service. William H. Dechant & Son, Reading, Pa., are engineers.

S. D., Huron—The City Council, Huron, is asking bids until Mar. 24, for an elevated steel water tank, capacity 300,000 gals. for municipal water service. O. A. Ricker is city engineer.

Tenn., Kingsport—The Tennessee-Eastman Corporation, Kingsport, a subsidiary of the Eastman Kodak Co., Rochester, N. Y., plans installation of electric power equipment in proposed new plant addition to cost over $350,000.

Tenn., Memphis—The Memphis Natural Gas Co., Memphis, plans installation of a number of air compressor stations, in connection with a proposed new natural gas line to Covington and other points in Western Tennessee, entire project to cost more than $2,000,000.

Texas, Henderson—The East Texas Refining Co., Post Office Building, Henderson, plans installation of pumping machinery and other power equipment in proposed new local oil refinery, to have a capacity of 6000 barrels of refined oil daily, entire project reported to cost over $200,000.

Texas, Hockley—The Houston Salt Co., Esperson Building, Houston, plans installation of electric power equipment in proposed new salt mining and refining plant in vicinity of Hockley, entire project reported to cost over $100,000.

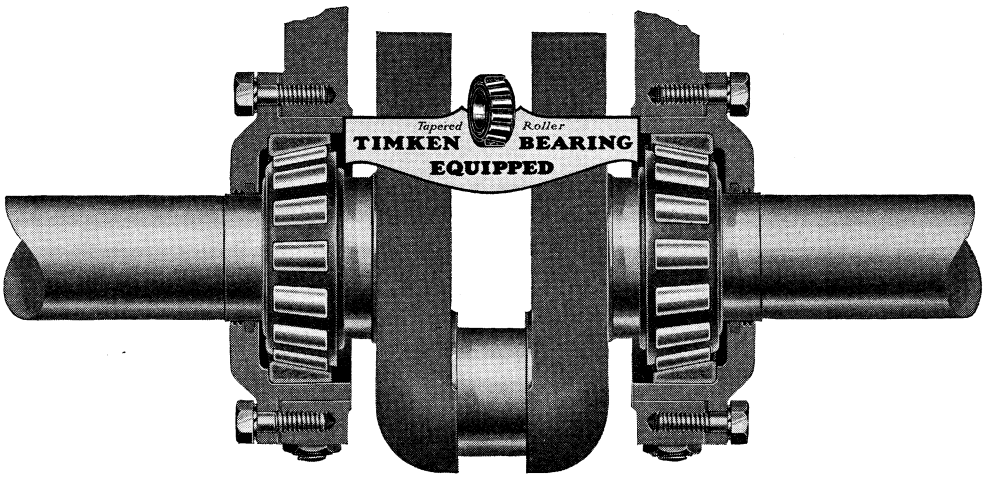
Texas, Longview—The Independent Ice Co., Dallas, Texas, is said to be planning a new ice-manufacturing plant at Longview, estimated to cost about $50,000, with machinery.

Wash., Camas—The Crown Willamette Paper Co., Camas, plans installation of electric power equipment in connection with a proposed new mill unit now under consideration, entire project reported to cost more than $800,000. Headquarters are at 343 Sansome Street, San Francisco, Calif.

Wash., Seattle—The Rainier Furniture Co., Seattle, plans installation of electric power equipment in connection with proposed rebuilding of furniture factory recently destroyed by fire with loss approximating $100,000.

Wis., Bloomer—The City Council is said to have preliminary surveys under way, and will soon make estimates of cost for a municipal power plant. A. H. Martin, Prairie du Chien, Wis., is engineer.

Wis., Racine—The Board of Water Commissioners is said to be planning a call for bids in April or May, for a proposed filtration plant and pumping station for municipal waterworks to cost over $400,000. Alvord, Burdick & Howson, 20 North Wacker Drive, Chicago, Ill., are consulting engineers.



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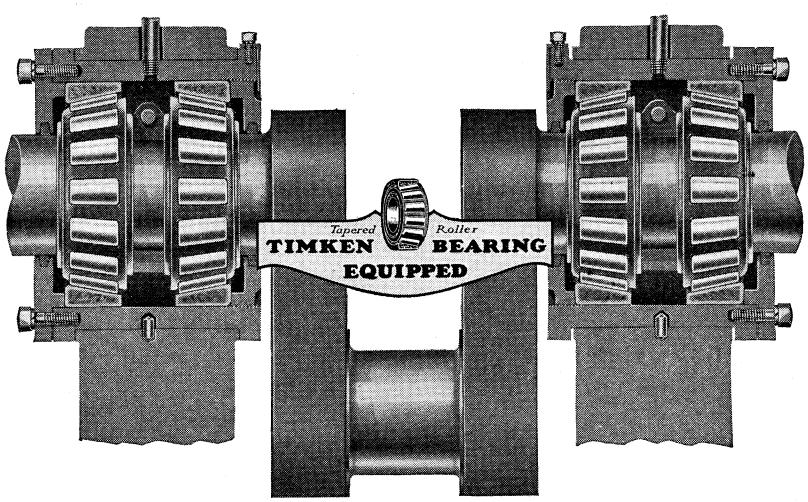

Machinery, Equipment and Supplies Used In The Production and Transmission of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear.

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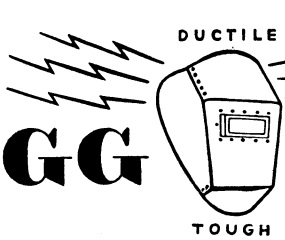

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Mohawk Water Treatment Co., Cleveland, Ohio.
National Aluminate Corp., Chicago, Ill.
Scaife & Sons Co., Wm. B., Oakmont, Pa.
Victor Chemical Wks., Chicago.

FILTERS, OIL
Anderson Co., V. D., Cleveland.
Burt Mfg. Co., The, Akron, O.

FILTERS, WATER
Cochrane Corp., Philadelphia.
Scaife & Sons Co., Wm. B. Oakmont, Pa.

FIRE BRICK
Babcock & Wilcox Co., N. Y.
Harbison-Walker Refrac. Co., Pittsburg, Pa.
Keystone Refractories Co., Inc., New York.
McLeod & Henry Co., Troy, N. Y.
Plibrico Jointless Firebrick Co., Chicago, Ill.

FIRE BRICK CEMENT
McLeod & Henry Co., Troy, N. Y.

FIRE BRICK PLASTIC
Plibrico Jointless Firebrick Company, Chicago, Ill.

FIRE CLAY
Keystone Refractories Co., Inc., New York.

FIRE HYDRANTS
Kennedy Valve Mfg. Co., Elmira, N. Y.

FITTINGS, AMMONIA
Frick Co., Waynesboro, Pa.

FITTINGS, FLANGE AND PIPE
Fisher Governor Co., Inc., Marshalltown, Iowa.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Limbert & Co., Geo. B., Chicago.
Stockham Pipe & Fittings Co., Birmingham, Ala.
Walworth Co., Boston, Mass.

FLANGES
Dart Mfg. Co., E. M., Providence, R. I.
Limbert & Co., Geo. B., Chicago.
Stockham Pipe & Fittings Co., Birmingham, Ala.
Walworth Co., Boston, Mass.

FLOATS
Anderson Co., V. D., Cleveland.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Reliance Gauge Column Co., Cleveland, O.

FLOW METERS
Bailey Meter Co., Cleveland, O.
Brown Inst. Co., The, Phila.
Meriam Co., Cleveland
Republic Flow Meters Co., Chicago.

FLUE CLEANERS
Bayer Co., The, St. Louis, Mo.
Diamond Power Spec. Corp., Detroit, Mich.
General Specialty Co., Buffalo.
Huyette Co., Inc., Paul B., Philadelphia.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh.
Pierce Co., Wm. B., Buffalo.

FURNACE BOTTOMS, CAST IRON AIR COOLED
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

FURNACE CONSTRUCTION & REPAIRS
Plibrico Jointless Firebrick Co., Chicago, Ill.

FURNACE FIRE OBSERVERS
Springfield Boiler Co., Springfield, Ill.
Fuller Lehigh Co., Fullerton, Pa.
Superheater Co., The, New York.

FURNACE SURFACES, WATER COOLED
Foster Wheeler Corp., New York.

FURNACE WALLS
Combustion Engrg. Corp., N. Y.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Superheater Co., The, New York.

FURNACES
Erie City Iron Works, Erie, Pa.

FURNACES, WATER COOLED
Erie City Iron Works, Erie, Pa.

GAS BURNERS
Peabody Engineering Corp., New York, N. Y.

GASKETS
Crandall Packing Co., Palmyra,
Darcoid Co., Inc., New York, N. Y.
Frick Co., Waynesboro, Pa.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Metallo Gasket Co., New Brunswick, N. J.
Smooth-On Mfg. Co., Jersey City.

GAUGE COCKS
Belfield Co., H., Philadelphia.
Ernst & Co., Newark, N. J.
Huyette Co., Inc., Paul B. Philadelphia.
Lonergan Co., J. E., Phila.
Reliance Gauge Column Co., Cleveland, O.

GAUGE GLASSES
Ernst & Co., Newark, N. J.
Jenkins Bros., New York.

GAUGE TESTERS
Ashton Valve Co., The, Boston
Fisher Governor Co., Inc., Marshalltown, Iowa.

GAUGE, DIFFERENTIAL
Ashton Valve Co., The, Boston.

GAUGES
Condenser Service & Engineering Co., Hoboken, N. J.

GAUGES, DRAFT
Bailey Meter Co., Cleveland, O.
Bristol Co., The, Waterbury.
Brown Inst. Co., The, Phila.
Huyette Co., Inc., Paul B., Philadelphia.
Pierce Co., Wm. B., Buffalo.
Republic Flow Meters Co., Chicago.

GAUGES, LIQUID LEVEL
Bristol Co., The, Waterbury.
Republic Flow Meters Co., Chicago

GAUGES, PRESSURE AND RECORDING
Ashton Valve Co., The, Boston.
Bristol Co., The, Waterbury.
Lonergan Co., J. E., Phila.

GAUGES, WATER
Anderson Co., V. D., Cleveland.
Ernst & Co., Newark, N. J.
Huyette Co., Inc., Paul B., Philadelphia.
Longeran Co., J. E., Phila.
Lunkenheimer Co., Cincinnati, O.
Reliance Gauge Column Co., Cleveland, O.
Yarnall-Waring Co., Phila.

GEARS, DOUBLE HELICAL
De Laval Steam Turbine Co., Trenton, N. J.
Terry Steam Turbine Co., Hartford, Conn.

GEARS, REDUCTION
De Laval Steam Turbine Co., Trenton, N. J.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GENERATING SETS
Allis-Chalmers Mfg. Co., Milwaukee.
Fairbanks, Morse & Co., Chicago, Ill.
Moore Steam Turbine Corp., Wellsville, N. Y.
Sturtevant Co., B. F., Boston.
Terry Steam Turbine Co., The, Hartford, Conn.
Troy Engine & Machine Co., Troy, Pa.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GENERATORS, ELECTRIC
Allis-Chalmers Mfg. Co., Milwaukee.
Elliott Co., Jeannette, Pa.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GOVERNORS, PUMP
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Northern Equipment Co., Erie.
Squires Co., C. E., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.

GRAPHITE
Dixon Crucible Co., Jos., Jersey City, N. J.

GRATES
Kelley Fdry. & Mach. Co., The, Goshen, Ind.
Neemes Foundry, Inc., Troy, N. Y.

GREASE
Dearborn Chem. Co., Chicago.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Phila.
Standard Oil Co. (Indiana), Chicago, Ill.
Vacuum Oil Co., New York.

GREASE CUPS
(See Oil and Grease Cups.)

GUNS, CEMENT
Quigley Co., Inc., New York.

GUNS, REFRACTORY
Cement-Gun Co., Inc., The, Allentown, Pa.
Quigley Co., Inc., New York.

HEAT EXCHANGERS
Babcock & Wilcox Co., N. Y.
Elgin Softener Corp., Elgin, Ill.
Foster Wheeler Corp., New York.
National Pipe Bending Co., New Haven, Conn.
Superheater Co., The, New York.
Vogt Mach. Co., Inc., Henry, Louisville.
Wheeler Mfg. Co., C. H., Phila.

HEATERS, BLEEDER
Foster Wheeler Corp., New York.

HEATERS FOR SPECIAL PURPOSES
National Pipe Bending Co., New Haven, Conn.

HEATERS, HOT WATER
Foster Wheeler Corp., New York.
National Pipe Bending Co., New Haven, Conn.

HEATERS, OIL
National Pipe Bending Co., New Haven, Conn.
Wheeler Mfg. Co., C. H., Phila.

HEATERS, STORAGE
National Pipe Bending Co., New Haven, Conn.

HEATING DEVICES
Cutler-Hammer, Inc., Milwaukee, Wisc.

HOISTS, SKIP
Fairfield Engineering Co., Marion, Ohio
Stephens-Adamson Mfg. Co., Aurora, Ill.

HOPPERS AND BINS, COAL AND ASH
Allen-Sherman-Hoff Co., Phila.
Connery & Co., Inc., Phila.

HYDROMETERS
Taylor Instr. Co.'s Rochester, N. Y.

HYGRODIEKS
Taylor Instr. Co.'s Rochester, N. Y.

ICE MAKING & REFRIGERATING MACHY.
Frick Co., Waynesboro, Pa.
Vogt Mach. Co., Inc., Henry, Louisville.

INJECTORS AND INSPIRATORS
Superheater Co., The, New York.

INSTRUMENTS, ELECTRICAL
Leeds and Northrup Co., Phila.

INSULATING MATERIAL
Cutler-Hammer, Inc., Milwaukee, Wisc.

JOINTS, EXPANSION
Foster Wheeler Corp., New York.
Kellogg Co., M. W., New York.
Wheeler Mfg. Co., C. H., Phila.
Yarnall-Waring Co., Philadelphia, Pa.

LABORATORY-FURNACES
Babcock & Wilcox Co., N. Y.

LININGS, COAL BUNKER
Wailes Dove-Hermiston Corp., N. Y.

LOADERS & UNLOADERS
Fairfield Engineering Co., Marion, Ohio

LUBRICANTS
Dearborn Chem. Co., Chicago.
Dixon Crucible Co., Jos., Jersey City, N. J.
Economy Lubricating Co., Charlestown, Mass.
Keystone Lubricating Co., Phila.
Standard Oil Co. (Indiana), Chicago, Ill.
Vacuum Oil Co., New York.

LUBRICATORS
Greene, Tweed & Co., New York.
Keystone Lubricating Co., Phila.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Powell Co., The Wm., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, O.

LUBRICATORS, FORCED FEED
Greene, Tweed & Co., New York.
Manzel Bros. Co., Buffalo, N. Y.

MANOMETERS
Meriam Co., Cleveland

MECHANICAL DRAFT APPARATUS
Sturtevant Co., B. F., Boston.
Wing Mfg. Co., L. J., New York.

METERS, AIR AND GAS
Bailey Meter Co., Cleveland, O.
Republic Flow Meters Co., Chicago, Ill.

METERS, BOILER
Bailey Meter Co., Cleveland, O.
Brown Inst. Co., The, Phila.
Republic Flow Meters Co., Chicago, Ill.
Yarnall-Waring Co., Phila.

METERS, COAL
Bailey Meter Co., Cleveland, O.
Republic Flow Meters Co., Chicago, Ill.

METERS, FEED WATER
Bailey Meter Co., Cleveland, O.
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago, Ill.
Worthington Pump & Machy. Corp., New York.
Yarnall-Waring Co., Philadelphia, Pa.

METERS, STEAM
Bailey Meter Co., Cleveland, O.
Brown Inst. Co., The, Phila.
Republic Flow Meters Co., Chicago, Ill.

METERS V-NOTCH
Yarnall-Waring Co., Phila.

METERS, WATER
Bailey Meter Co., Cleveland, O.
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago, Ill.

MONEL METAL RINGS, RODS, CASTINGS, FORGINGS, TUBING, SHEETS, WIRE AND WIRE CLOTH
International Nickel Co., N. Y.

MOTORS
Allis-Chalmers Mfg. Co., Milwaukee.
Fairbanks, Morse & Co., Chicago,
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

NOZZLES FOR ALL PURPOSES
Yarnall-Waring Co., Philadelphia, Pa.

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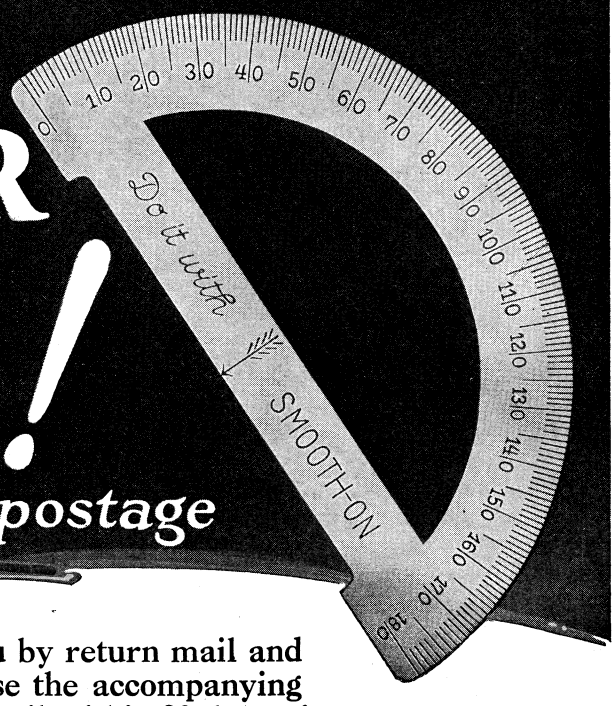

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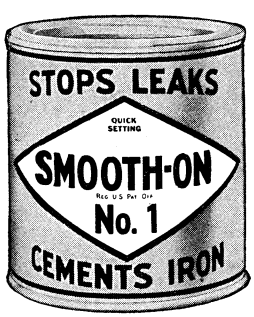

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OIL AND GREASE CUPS
Keystone Lubricating Co., Phila.
Lonergan Co., J. E., Phila.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

OIL BURNING EQUIPMENT
Combustion Engrg. Corp., N. Y.
Engineer Co., The, New York.
Peabody Engrg. Corp., N. Y.

OIL, COAL, GAS, BURNER
Engineer Co., The, New York.
Peabody Engrg. Corp., N. Y.

OIL PURIFIERS
De Laval Separator Co., N. Y.
De Laval Steam Turbine Co., Trenton, N. J.

OIL SEPARATORS
De Laval Separator Co., N. Y.
Elliott Co., Jeannette, Pa.

OIL TANKS
Manzel Bros. Co., Buffalo, N. Y.

OILING SYSTEMS
Burt Mfg. Co., The, Akron, O.
DeLaval Separator Co., N. Y.

OILS, LUBRICATING
Dearborn Chemical Co., Chicago.
Standard Oil Co. (Indiana), Chicago, Ill.
Vacuum Oil Co., New York.

PACKING, ASBESTOS
Crandall Packing Co., Palmyra,

PACKING, CENTRIFUGAL PUMP
Crandall Pkg. Co., Palmyra,

PACKING, FIBRE
Condenser Service & Engineering Co., Hoboken, N. J.

PACKING, FLAX
Crandall Packing Co., Palmyra,

PACKING, METALLIC
Condenser Service & Engineering Co., Hoboken, N. J.
Crandall Pkg. Co., Palmyra,

PACKING, PISTON AND ROD
Crandall Pkg. Co., Palmyra,
Darcoid Co., Inc., New York, N. Y.
Goetze Gasket & Packing Co., New Brunswick, N. J.

PACKING, SHEET
Crandall Packing Co., Palmyra.
Darcoid Co., Inc., New York, N. Y.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Jenkins Bros., New York.

PACKING, VALVE STEM
Crandall Pkg. Co., Palmyra,
Darcoid Co., Inc., New York, N. Y.

PAINT, ACID, ALKALI AND WATER RESISTANT
Quigley Co., Inc., New York.

PAINT, ANTI-CORROSIVE
Master Mechanics Co., Cleveland,
Wailes Dove - Hermiston Corp., N. Y.

PAINT, FLOOR
Wailes Dove - Hermiston Corp., N. Y.

PAINT, GRAPHITE
Dixon Crucible Co., Jos., Jersey City, N. J.

PAINT, HEAT RESISTING
Wailes Dove-Hermiston Corp., New York.

PAINT, METAL
Master Mechanics Co., Cleveland,

PAINT, PROTECTIVE
Wailes Dove - Hermiston Corp., N. Y.

PAINT, STEEL PRESERVATIVE
Master Mechanics Co., Cleveland,

PIPE BENDING
Frick Co., Waynesboro, Pa.
Limbert & Co., Geo. B., Chicago.
Midwest Piping & Supply Co., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh, Pa.
Walworth Co., Boston, Mass.

PIPE COILS
Limbert & Co., Geo. B., Chicago.
Midwest Piping & Supply Co., St. Louis, Mo.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh.
Superheater Co., The, New York.
Vogt Mach. Co., Inc., Henry, Louisville.

PIPE CUTTERS
Borden Co., The, Warren, O.
Walworth Co., Boston, Mass.

PIPE FABRICATORS
Limbert & Co., Geo. B., Chicago.
Midwest Piping & Supply Co., St. Louis, Mo.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh, Pa.

PIPE HANGERS AND SUPPORTS
Limbert & Co., Geo. B., Chicago.

PIPE THREADING MACHINES
Borden Co., The, Warren, O.

PIPING
Connery & Co., Inc., Phila.
Kellogg Co., M. W., New York.
Limbert & Co., Geo. B., Chicago.
Midwest Piping & Supply Co., St. Louis, Mo.
Pittsburgh Piping & Equipment Co., Pittsburgh.
Power Piping Co., Pittsburgh.
Walworth Co., Boston, Mass.

PIPING CONTRACTING MANUFACTURERS
Kellogg Co., M. W., New York.
Limbert & Co., Geo. B., Chicago.
Midwest Piping & Supply Co., St. Louis, Mo.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Pope, Wm. A. Chicago.
Power Piping Co., Pittsburgh.

PLANIMETERS
Ashton Valve Co., Boston, Mass.

PORTABLE CONVEYORS
Fairfield Engineering Co., Marion, Ohio.

POWER PLANT MANAGEMENT
Stone & Webster, Inc., Boston,

PREHEATERS
Babcock & Wilcox Co., N. Y.

PROTECTIVE COATING
Master Mechanics Co., Cleveland,
Quigley Co., Inc., New York.

PULVERIZED COAL BURNERS
Erie City Iron Works, Erie, Pa.
Fuller Lehigh Co.. Fullerton, Pa.
Peabody Engineering Corp., New York, N. Y.

PULVERIZED COAL FEEDERS
Fuller Lehigh Co., Fullerton, Pa.

PULVERIZED FUEL EQUIPMENT
Combustion Engrg. Corp., N. Y.
Erie City Iron Works, Erie, Pa.
Foster Wheeler Corp., New York.
Fuller Lehigh Co., Fullerton, Pa.
Kennedy-Van Saun Mfg. & Eng. Corp., New York.

PULVERIZERS, COAL
American Pulverizer Co., St. Louis, Mo.
Fuller Lehigh Co., Fullerton, Pa.
Kennedy-Van Saun Mfg. & Eng. Corp., New York.
Pennsylvania Crusher Co., Phila.
Strong-Scott Mfg. Co., Minneapolis, Minn.

PULVERIZERS, LIMESTONE
American Pulverizer Co., St. Louis, Mo.
Fuller Lehigh Co., Fullerton, Pa.

PUMPS, AIR LIFT
Pennsylvania Pump & Compressor Co., Easton, Pa.

PUMPS, BOILER FEED
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago, Ill.
Foster Wheeler Corp., New York.
Frederick Iron & Steel Co., Frederick, Md.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works Co., Manistee, Mich.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford, Conn.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Machy. Corp., New York.

PUMPS, CENTRIFUGAL
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago, Ill.
Foster Wheeler Corp., New York.
Frederick Iron & Steel Co., Frederick, Md.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works Co., Manistee, Mich.
Moore Steam Turbine Corp., Wellsville, N. Y.
Nash Eng. Co., So. Norwalk.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Terry Steam Turbine Co., The, Hartford, Conn.
Warren Steam Pump Co., Inc., Warren, Mass.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., New York.

PUMPS, DEEP WELL
Fairbanks, Morse & Co., Chicago, Ill.
Worthington Pump & Machy. Corp., New York.

PUMPS, ELECTRIC
Frederick Iron & Steel Co., Frederick, Md.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, ELEVATOR AND FIRE
De Laval Steam Turbine Co., Trenton, N. J.
Frederick Iron & Steel Co., Frederick, Md.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works Co., Manistee, Mich.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, GENERAL SERVICE
Frederick Iron & Steel Co., Frederick, Md.
Nash Engrg. Co., S. Norwalk.

PUMPS, HYDRAULIC PRESSURE
Frederick Iron & Steel Co., Frederick, Md.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, JET
Manistee Iron Works Co., Manistee, Mich.

PUMPS, OIL
Frederick Iron & Steel Co., Frederick, Md.
Lonergan Co., J. E., Phila.
Manzel Bros. Co., Buffalo, N. Y.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, POWER
Fairbanks, Morse & Co., Chicago, Ill.
Frederick Iron & Steel Co., Frederick, Md.
Lecourtenay Co., Newark, N. J.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Machy. Corp., New York.

PUMPS, PULVERIZED COAL
Fuller Lehigh Co., Fullerton,

PUMPS, ROTARY
Manistee Iron Works Co., Manistee, Mich.
Wheeler Mfg. Co., C. H., Phila.

PUMPS, TURBINE
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, VACUUM
Foster Wheeler Corp., New York.
Manistee Iron Works Co., Manistee, Mich.
Nash Engrg. Co., S. Norwalk.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Warren Steam Pump Co., Inc., Warren, Mass.
Wheeler Mfg. Co., C. H., Phila.

PUMPS, WATERWORKS
Fairbanks, Morse & Co., Chicago, Ill.
Frederick Iron & Steel Co., Frederick, Md.
Lecourtenay Co.. Newark, N. J.
Manistee Iron Works Co., Manistee, Mich.
Moore Steam Turbine Corp., Wellsville, N. Y.
Warren Steam Pump Co., Inc., Warren, Mass.

PURIFIERS, BOILER FEED
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Permutit Co., New York, N. Y.
Scaife & Sons Co., Wm. B., Oakmont, Pa.

PYROMETERS
Bristol Co., The, Waterbury.
Brown Inst. Co., Philadelphia.
Leeds & Northrup Co., Philadelphia.
Republic Flow Meters Co., Chicago, Ill.
Superheater Co., The, New York.
Taylor Instr. Co.'s Rochester, N. Y.

QUENCHERS, ASH
Allen - Sherman-Hoff Co., The, Philadelphia, Pa.

RECORDERS, LIQUID LEVEL
Bristol Co., Waterbury, Conn.

RECORDERS, PRESSURE
Crosby Steam Gage & Valve Co., Boston, Mass.

RECORDING INSTRUMENTS
Bristol Co., The, Waterbury.
Leeds & Northrup Co., Phila.
Taylor Instr. Co.'s Rochester, N. Y.

REDUCING WHEELS
Ashton Valve Co.. Boston, Mass.

REFRACTORY PATCHING MATERIAL
Quigley Co., Inc., New York.

REFRACTORIES
Faulkner Refractories Co., J. A., Youngstown, Ohio
Harbison - Walker Refractories Co., Pittsburgh, Pa.
McLeod & Henry Co., Troy, N. Y.
Quigley Co., Inc., New York.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Rust Engrg Co., Pittsburgh.

REGULATORS, DAMPER
Atlas Valve Co., Newark, N. J.
Brown Inst. Co., The, Phila.
d'Este Co., Julian, Boston, Mass.
Engineer Co., The, New York.
Huyette Co., Inc., Paul B., Philadelphia.
Kieley & Mueller, Inc., New York.
Ruggles-Klingemann Mfg. Co., Salem, Mass.

REGULATORS, FAN ENGINE
Atlas Valve Co., Newark, N. J.

REGULATORS, FEED WATER
Atlas Valve Co., Newark, N. J.
Bailey Meter Co., Cleveland.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Northern Equipment Co., Erie.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York.
Squires Co., C. E., Cleveland, O.

REGULATORS, PRESSURE
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Kieley & Mueller, Inc., New York.
Northern Equipment Co., Erie.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York.
Squires Co., C. E., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.

REGULATORS, TEMPERATURE
Atlas Valve Co., Newark, N. J.
Bristol Co., The, Waterbury.
Brown Inst. Co., The, Phila.
d'Este Co., Julian, Boston.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Co., Inc., New York.
Taylor Instr. Co.'s Rochester, N. Y.

RESUPERHEATERS
Babcock & Wilcox Co., N. Y.

ROLLER BEARINGS
Timken Roller Bearing Co., The, Canton, O.

ROPE, TRANSMISSION
American Steel & Wire Co., Chicago-New York.

ROPE, WIRE
American Steel & Wire Co., Chicago-New York.

RUST PREVENTIVES
Dearborn Chem. Co., Chicago.

SCALE REMOVERS (Mechanical)
General Specialty Co., Buffalo.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh.
Pierce Co., Wm. B., Buffalo.
Roto Co., The, Newark, N. J.

SCRAPERS, DRAG
Sauerman Bros.. Inc., Chicago.

SEPARATORS, STEAM AND AIR
Nicholson & Co., W. H., Wilkes-Barre, Pa.

SEPARATORS AND EXTRACTORS, STEAM AND OIL
Anderson Co., V. D., Cleveland.
Cochrane Corp., Philadelphia.
d'Este Co., Julian, Boston, Mass.
Hoppes Mfg. Co., Springfield, O.
Kellogg Co., M. W., New York.
Kieley & Mueller, Inc., New York.
National Pipe Bending Co., New Haven, Conn.
Williams Valve Co., D. T., Cincinnati, O.

SLUICING SYSTEMS, ASH
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

SODIUM ALUMINATE
National Aluminate Corp., Chicago, Ill.

SOOT BLOWERS
Bayer Co., The, St. Louis, Mo.
Diamond Power Spec. Corp., Detroit, Mich.
Huyette Co., Inc., Paul B., Philadelphia.

SPEED RECORDERS
Leeds & Northrup Co., Phila.

SPRAY COOLING SYSTEM
Binks Mfg. Co., Chicago, Ill.
Yarnall-Waring Co. Phila.

SPRAY COOLING TOWERS
Binks Mfg. Co., Chicago, Ill.

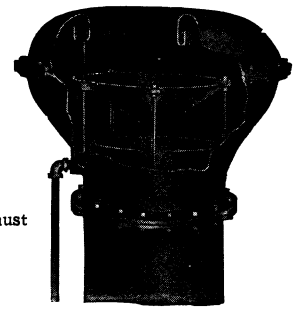
SPRAY NOZZLES
Binks Mfg. Co., Chicago, Ill.
Yarnall-Waring Co., Phila.

SPRAY PONDS
Binks Mfg. Co., Chicago, Ill.
Yarnall-Waring Co., Phila.

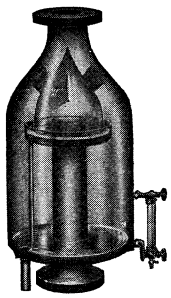
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

STACKS, METAL
Connery & Co., Inc., Phila.
Vogt Mach. Co., Inc., Henry, Louisville.

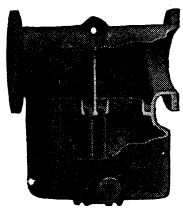
STEAM TRAPS
Anderson Co., V. D., Cleveland.
Armstrong Machine Works, Three Rivers, Mich.
Cochrane Corp., Philadelphia.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Kaye and MacDonald, Inc., West Orange, N. J.
Kieley & Mueller, Inc., New York.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Reliance Gauge Column Co., Cleveland, Ohio.
Sarco Co., Inc., New York.
Squires Co., C. E., Cleveland, O.



Hoppes Exhaust Head

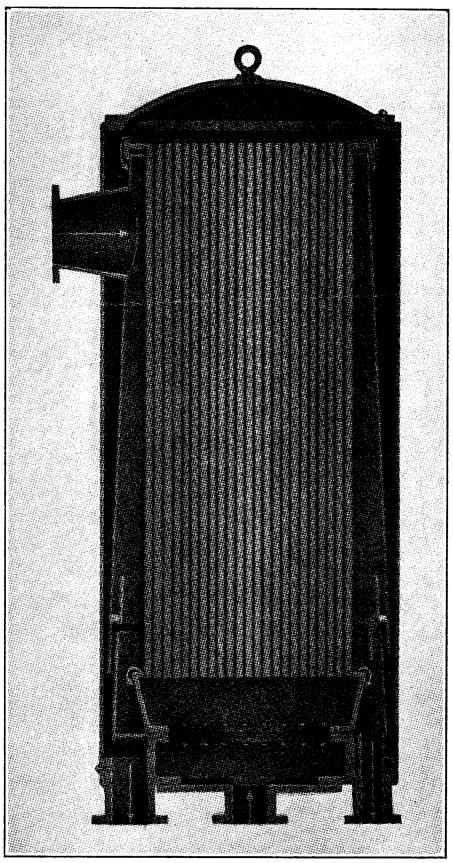


Hoppes Cast Iron Steam Separator



Hoppes Oil Eliminator

HOPPES Heat Saving Specialties cut plant operation costs



Hoppes Barometric Surface Condenser

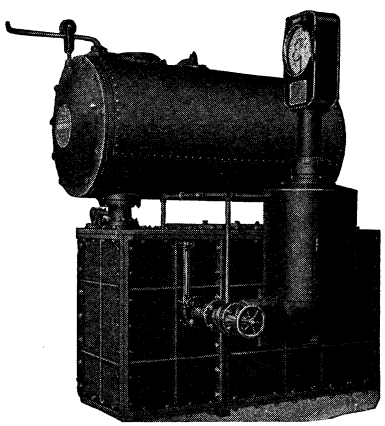
Hoppes Feed Water Heaters contain series of intercepting troughs that offer a large surface area over which the water flows, bringing it in intimate contact with the steam, resulting in rapid heating and complete precipitation of scale forming substances before the water enters the boiler.

The simplicity of the Hoppes System, the high percentage of heat recovery and the fact that no chemicals are required are important advantages in operating economy.

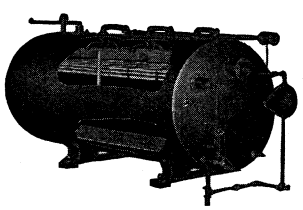
Hoppes Separators, horizontal, vertical and right angle type, are furnished in steel shell or cast iron construction. With no detachable parts to come loose, these separators have large chambers and intercepting troughs that prevent water from being picked up again by outgoing steam.

Hoppes Exhaust Heads give double service by protecting buildings and returning condensate for heat recovery in boiler make-up when desired. They are made of Hoppes rust-resistant gray-iron.

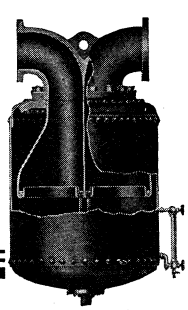
Write for Catalogue 90 which describes the complete line of Hoppes Specialties that are now serving in leading central stations and industrial plants.



Hoppes Heater with V-Notch Meter



Hoppes Exhaust Steam Feed Water Heater



Hoppes Steel Shell Steam Separators

The Hoppes Manufacturing Co.

70 Larch St., Springfield, Ohio

Watson & McDaniel Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, O.

STOCKS AND DIES
Borden Co., The, Warren, Ohio.

STOKERS
Babcock & Wilcox Co., N. Y.

STOKERS, CHAIN GRATE
Combustion Engrg. Corp., N. Y.

STOKERS, HAND-OPERATED
Kelly F'dry. & Mach. Co., Goshen.

STOKERS, MECHANICAL
American Engrg. Co., Phila.
Combustion Engrg. Corp., N. Y.
Detroit Stoker Co., Detroit.

STOKERS, OVERFEED
Detroit Stoker Co., Detroit.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

STOKERS, UNDERFEED
American Engrg. Co., Phila.
Combustion Engrg. Corp., N. Y.
Detroit Stoker Co., Detroit.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

STRAINERS
Sarco Co., Inc., New York.

STRAINERS, OIL
Sarco Co., Inc., New York.

SUPERHEATERS, STEAM
Babcock & Wilcox Co., N. Y.
Badenhausen Corp., Cornwells Heights, Pa.
Foster Wheeler Corp., New York.
Superheater Co., The, New York.

SWITCHES
Cutler-Hammer, Inc., Milwaukee, Wisc.

TACHOMETERS
Bristol Co., The, Waterbury.
Brown Instr. Co., The, Phila.

TANKS
Connery & Co., Inc., Phila.
Kellogg Co., M. W., New York.
Scaife & Sons Co., Wm. B., Oakmont, Pa.
Vogt Mach. Co., Inc., Henry, Louisville.

THERMOCOUPLES
Leeds & Northrup Co., Phila.

THERMOMETERS
Ashton Valve Co., Boston, Mass.
Bristol Co., The, Waterbury.
Condenser Service & Engineering Co., Hoboken, N. J.
Leeds & Northrup Co., Phila.
Taylor Instr. Co.'s Rochester, N. Y.

THERMOMETERS, RECORDING AND INDICATING
Bristol Co., The, Waterbury.
Brown Inst. Co., The, Phila.
Leeds & Northrup Co., Phila.
Taylor Instrument Cos., Rochester, N. Y.

TRAMWAYS
American Steel & Wire Co., Chicago-New York.

TRAPS, COMPRESSED AIR
Armstrong Machine Wks., Three Rivers, Mich.
Kaye & MacDonald, Inc., West Orange, N. J.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

TRAPS, RADIATOR
Sarco Co., Inc., New York, N. Y.

TRAPS, RETURN
d'Este Co., Julian, Boston. Mass.
Kieley & Mueller, Inc., New York.
Sarco Co., Inc., New York.

TRAPS, STEAM AND RADIATOR
Armstrong Machine Wks., Three Rivers, Mich.
Kaye & MacDonald, Inc., West Orange, N. J.
Sarco Co., Inc., New York.

TRAPS, VACUUM
Armstrong Machine Wks., Three Rivers, Mich
Kaye & MacDonald, Inc., West Orange, N. J.

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Lagonda Mfg. Co., Springfield, O.

TUBING, CONDENSER
Condenser Service & Engineering Co., Hoboken, N. J.
Foster Wheeler Corp., New York.

TURBINES, HYDRAULIC
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.

TURBINES, STEAM
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
Moore Steam Turbine Co., Wellsville, N. Y.
Sturtevant Co., B. F., Boston,
Terry Steam Turbine Co., The, Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Wing Mfg. Co., L. J., New York.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Elliott Co., Jeannette, Pa.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

UNIONS
Atlas Valve Co., Newark, N. J.
Dart Mfg. Co., E. M., Providence, R. I.
Walworth Co., Boston, Mass.

VACUUM CLEANING SYSTEMS
Sturtevant Co., B. F., Boston.

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Goetze Gasket & Packing Co., New Brunswick, N. J.
Jenkins Bros., New York, N. Y.
Metallo Gasket Co., New Brunswick, N. J.

VALVES
Atlas Valve Co., Newark, N. J.
Condenser Service & Engineering Co., Hoboken, N. J.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Powell Co., The Wm., Cincinnati, Ohio.
Vogt Mach. Co., Inc., Henry, Louisville.

VALVES, ALTITUDE
Kieley & Mueller, Inc., New York.

VALVES, AUTOMATIC CUT-OFF
Elliott Co., Jeannette, Pa.
Fisher Governor Co., Inc., Marshalltown, Iowa.

VALVES, AUTOMATIC STOP AND CHECK
Ruggles-Klingemann Mfg. Co., Salem, Mass.

VALVES, BLOW-OFF
Crosby Steam Gage & Valve Co., Boston, Mass.
Everlasting Valve Co., Jersey City, N. J.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
Powell Co., The Wm., Cincinnati, Ohio.
Yarnall-Waring Co., Phila.

VALVES, BY-PASS
Jenkins Bros., New York, N. Y.

VALVES, CHECK
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Powell Co., The Wm., Cincinnati, Ohio.
Walworth Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, FLOAT
Atlas Valve Co., Newark, N. J.
Crosby Steam Gage & Valve Co., Boston, Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Kieley & Mueller, Inc., New York.
Yarnall-Waring Co., Phila.

VALVES, GATE
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Powell Co., The Wm., Cincinnati, Ohio.
Vogt Mach. Co., Inc., Henry, Louisville.
Walworth Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, GLOBE
Belfield Co., H., Philadelphia.
Crosby Steam Gage & Valve Co., Boston, Mass.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Vogt Mach. Co., Inc., Henry, Louisville.
Walworth Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnai, O.

VALVES, HYDRAULIC
Kennedy Valve Mfg. Co., Elmira, N. Y.
Vogt Mach. Co., Inc., Henry, Louisville.
Yarnall-Waring Co., Phila.

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Kieley & Mueller, Inc., New York.
Ruggles - Klingemann Mfg. Co., Salem, Mass.

VALVES, POP SAFETY
Ashton Valve Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila.
Lunkenheimer Co., Cincinnati, O.

VALVES, PUMP
Crosby Steam Gage & Valve Co., Boston, Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Jenkins Bros., New York.

VALVES, RADIATOR
Jenkins Bros., New York.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, REDUCING
Atlas Valve Co., Newark, N. J.
Belfield Co., H., Philadelphia.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
d'Este Co., Julian, Boston. Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Kieley & Mueller, Inc., New York, N. Y.
Northern Equipment Co., Erie,
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Squires Co., C. E., Cleveland, Ohio.
Watson & McDaniel Co., Philadelphia, Pa.

VALVES, REGRINDING
Kennedy Valve Mfg. Co., Elmira, N. Y.
Powell Co., The Wm., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, REGULATING
Atlas Valve Co., Newark, N. J.
Belfield Co., H., Philadelphia.
Northern Equipment Co., Erie.

VALVES, RELIEF
Cochrane Corp., Philadelphia.
Crosby Steam Gage & Valve Co., Boston, Mass.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Lonergan Co., J. E., Phila.

VALVES, STEEL
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.

VALVES, STOP
Crosby Steam Gage & Valve Co., Boston, Mass.

VALVES, THREE AND FOUR WAY
Nicholson & Co., W. H., Wilkes-Barre, Pa.

VENTILATING APPARATUS
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Sturtevant Co., B. F., Boston.
Wing Mfg. Co., L. J., New York.

WASTE HEAT RECOVERY SYSTEMS
Babcock & Wilcox Co., N. Y.
Edge Moor Iron Co., Edge Moor.

WATER BACKS, HIGH AND LOW PRESSURE
Foster Wheeler Corp., New York.

WATER COLUMNS AND ALARMS
Anderson Co., The V. D., Cleveland, Ohio.
Lunkenheimer Co., Cincinnati, O.
Reliance Gauge Column Co., Cleveland, Ohio.
Yarnall-Waring Co., Phila.

WATER COOLING EQUIPMENT
Yarnall-Waring Co., Philadelphia, Pa.

WATER PURIFYING APPARATUS
Elgin Softener Corp., Elgin, Ill.

WATER SOFTENING SYSTEMS
Cochrane Corp., Philadelphia.
Dearborn Chemical Co., Chicago.
Elgin Softener Corp., Elgin, Ill.
National Aluminate Corp., Chicago, Ill.
Scaife & Sons Co., Wm. B., Oakmont, Pa.
Victor Chemical Wks., Chicago.

WATER TESTING EQUIPMENT
National Aluminate Corp., Chicago, Ill.

WATER WALLS
Edge Moor Iron Co., Edge Moor.
Fuller Lehigh Co., Fullerton, Pa.
Springfield Boiler Co., Springfield, Ill.

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Fairfield Engineering Co., Marion, Ohio.
Sintering Machinery Corp., New York, N. Y.
Stephens - Adamson Mfg. Co., Aurora, Ill.

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Midwest Piping & Supply Co., St. Louis, Mo.

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Lonergan Co., J. E., Phila.
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WIRE OF EVERY DESCRIPTION
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American Steel & Wire Co., Chicago-New York.

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Curtis Balanced Steam Trap

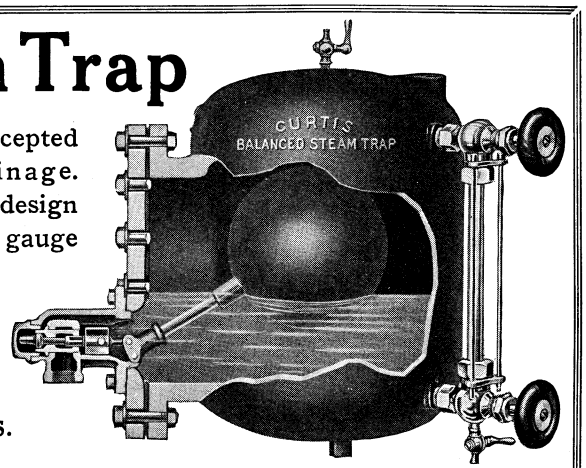
Trade Mark

D'ESTE

For years Curtis Traps have been an accepted high standard for dependable steam drainage. Curtis large area seat with balanced valve design insures, maximum capacity and the water gauge proves its efficient operation.

Built for service—not to meet a price.

Send for No. 61 Catalogue



JULIAN D'ESTE COMPANY

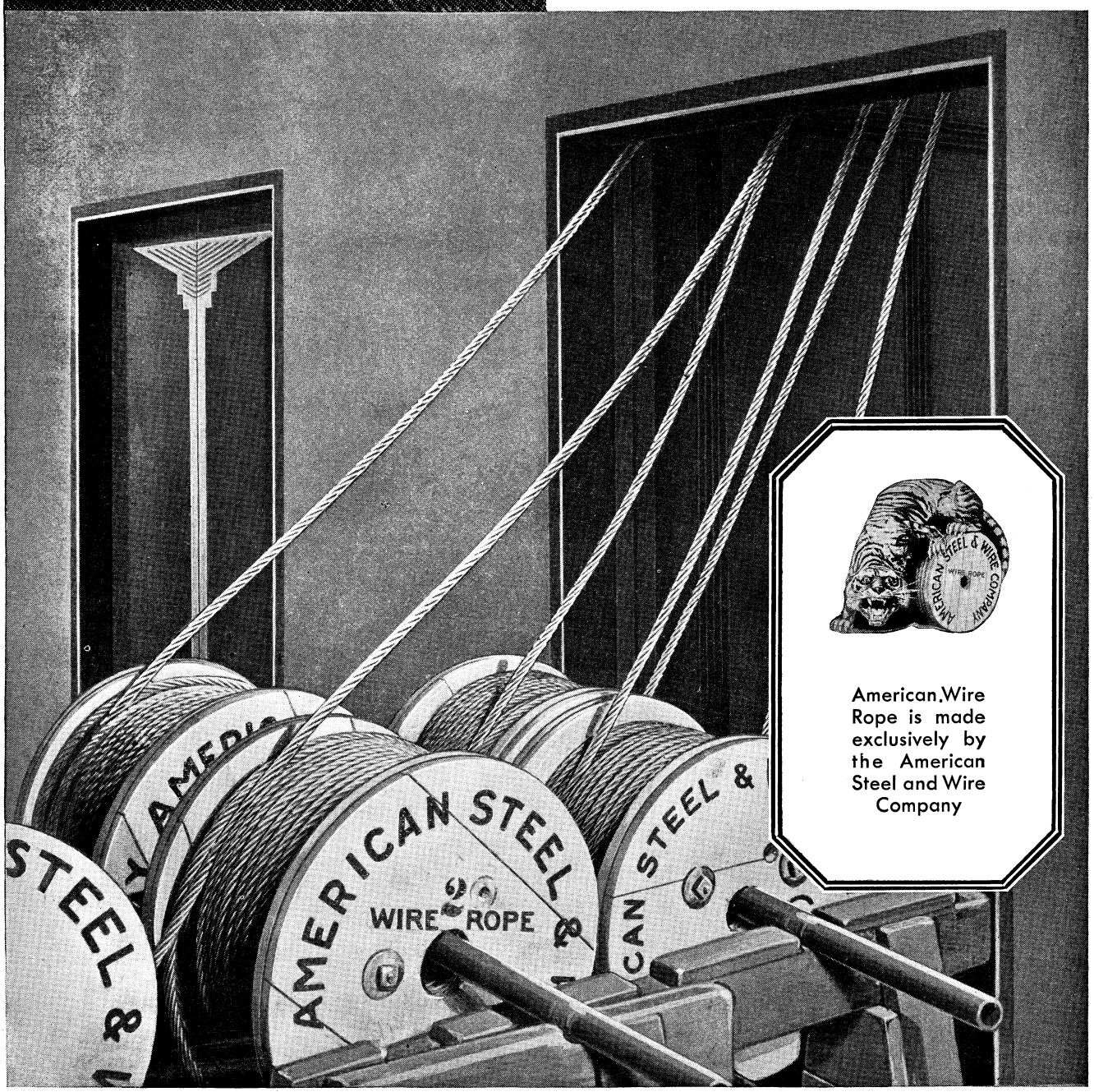
6 Spice St. (Charlestown Dist.), BOSTON, MASS.

Established 1870

AMERICAN STEEL & WIRE COMPANY WIRE ROPE

For Safety and Low Maintenance

Because safety and economy of operation are of vital importance in building management—you will, in a great majority of cases, see American Steel & Wire Company American Wire Rope being installed in elevator shafts. Designed to give maximum resilience, flexibility and traction effort, combined with smooth running qualities, it has established remarkable performance records. Our engineers will gladly assist you in choosing elevator wire ropes.



American Wire Rope is made exclusively by the American Steel and Wire Company

1831 COMMEMORATING AMERICAN STEEL & WIRE COMPANY 100 YEARS of PROGRESS IN WIRE MAKING 1931

AMERICAN STEEL & WIRE COMPANY

208 South La Salle Street, Chicago SUBSIDIARY OF UNITED STATES STEEL CORPORATION And All Principal Cities

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Advertisements in the Signboard Section which come under the classification "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patents and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

50 cents a line

each insertion, 6 words to a line; minimum sold, 4 lines.

For display of any advertisement under the classified headings see sizes and rates in column at right.

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Advertisements in Signboard Section which comes under the classification "Equipment for Sale," "Equipment Wanted," "Educational and Instruction," and "Miscellaneous" are set in display space of the following sizes and at these rates:

1 in.	$ 5.50	4 in.	$20.80
2 in.	10.80	1 col. (8½ in.)	43.35
3 in.	15.90	2 col. (17 in.)	85.00

Not less than one inch to be sold in these classifications.

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ENGINEERING SALES AGENCY IN THE Northwest desires a few additional accounts. Manufacturers seeking representation in the states of Washington and Oregon are offered an opportunity to sell power plant equipment through this well organized and securely established firm which is well known in the territory. Write to Box 1088, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

NEW JERSEY SALES AGENCY—OLD AND well established sales engineering firm covering the state of New Jersey, especially from Trenton North. Will consider new lines of power plant equipment used in conjunction with packing. Will not consider boiler compounds. Manufacturers interested in securing the highest kind of representation in this territory write to Box 1089, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

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EUROPEAN DISTRIBUTOR. A general distributor selling direct to factories of high financial rating in Europe wishes to secure two or three additional American power or mechanical specialties. This firm has a large and well-trained organization and has been established over twenty-five years. American power specialty manufacturers interested in this unusual opportunity to secure a selling channel in Europe please write to Box 1081, Power Plant Engineering, 53 West Jackson Blvd., Chicago, Ill.

SALES ENGINEERS. Boston. Well established, desire power plant equipment account. Salary and commission or commission and part expenses. Address Box 1079, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

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TESTING ENGINEER available for Central Station work. Graduate mechanical engineer. 5 years engineering experience. Age 30 years. Desires a position with the Efficiency Department of a Central Station. Please write to Box 1084, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

POWER ENGINEER available. 10 years experience as Superintendent, Test Engineer, Combustion, and Maintenance work in both Industrial Plants and Utilities. Technical graduate. Member, Institute of Mechanical Engineers, Royal Society of Combustion Engineers, etc. Now employed as Chief Operating and Test Engineer for a firm of Consulting, Managing and Construction Engineers, of International Scope. Would consider either a United States or Foreign connection. Please write to Box 1083, Power Plant Engineering, 53 Jackson Blvd., Chicago, Ill.

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ELECTRICAL, steam and mechanical equipment ideas developed. Patents secured and inventions financed and marketed. Address Box 1085, Power Plant Engineering, 53 West Jackson Blvd., Chicago, Ill.

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PATENTS—Booklet free. Highest references. Best results. Promptness assured. Send drawing or model. WATSON E. COLEMAN, Registered Patent Lawyer, 724 9th Street, Washington, D. C.

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YEARLY CONTRACT BASIS

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Send me AUDELS ENGINEERS AND MECHANICS GUIDES. 8 numbers, $12, for *free examination.* If satisfactory, I will send you $1 in 7 days, then $1 monthly until $12 is paid.

Name.....

Address.....

Occupation.....

Employed by..... **P.P.E.**

SIGNBOARD SECTION

Quick Action Opportunities

EQUIPMENT WANTED

WANTED

1000 KW (Approx.) General Electric Steam Turbine Generator Set with surface condenser and all equipment. 2 or 3 phase 60 cycle. Prefer modern machine with exciter on shaft. Immediate inspection and purchase if price low. **Box 1087**

POWER PLANT ENGINEERING
53 W. Jackson Blvd., Chicago, Ill.

WANTED

Two 200 to 225 hp. Water Tube Boilers, 180 to 200 lb. pressure.

State price, type and location.

Address Box 1082, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

EQUIPMENT FOR SALE

200 KVA
CHUSE 4 VALVE UNIT

200 KVA. SPF 3 ph. 60 cy. 2300 volt 200 RPM. Western Electric type TRE Generator direct connected to 17x21 chuse 4 valve non-releasing right hand engine with belted exciter.

Excellent Condition — Reasonably Priced

Just one of many desirable units we have available for immediate delivery. Send for bulletin No. 38, 72 illustrated pages of ROCKFORD REBUILT motors, generators, turbines, transformers, etc.

ROCKFORD POWER MACHINERY CO.
620 Seventh St. Rockford, Illinois

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ENGINE SETS

780 KVA G.E.—24x30 Erie Ball 4v.
500 KVA C.W.—24x30 Chuse 4v.
500 KVA G.E.—20x30 Ames Uniflow
450 KVA G.E.—23x28 Chuse 4v.
375 KVA G.E.—24x24 Ridgeway 4v.
312 KVA G.E.—18x22 Erie Ball 4v.
312 KVA G.E.—21x22 Skinner Uniflow
187 KVA G.E.—19x20 Skinner Uniflow
90 KVA G.E.—14x14 Ames Uniflow

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1250 KVA Wghse (bleeder)
937 KVA Wghse (bleeder)
625 KVA Wghse (back pres. 40 lbs.)
625 KVA Wghse (bleeder)

POWER PLANT EQUIPMENT CO., Inc.
39-41 Cortlandt St., New York City, N. Y.

Volume I

Electricity—What It Is and How It Acts

BY

ANDREW W. KRAMER

Associate Editor Power Plant Engineering, Associate Member American Institute of Electrical Engineers, Institute of Radio Engineers

288 pages, 5½ x 8, bound in maroon cloth, 130 illustrations, $2 postpaid

Published by

TECHNICAL PUBLISHING COMPANY
53 W. Jackson Blvd., Chicago

To Whom Will The Buyer Turn?

A very shrewd and successful machinery dealer stated the other day that the time has now arrived to transfer his personal investments from Government Bonds (where he has had them for the last two years) to industrial stocks and bonds. In this man's opinion, right now is the time to prepare for the return of normal prosperity.

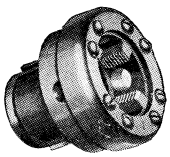
To be in a position to take full advantage of the return of normal buying the equipment dealer must keep his offerings and his Company name conspicuously before his market. The power plant market is reached effectively and economically through

THE SIGNBOARD SECTION

POWER PLANT ENGINEERING, 53 W. Jackson Blvd.
Chicago, Illinois

Modernize Your Shop with —

These New and Improved Beavers!



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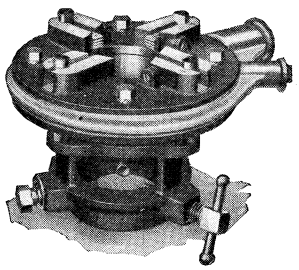
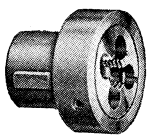
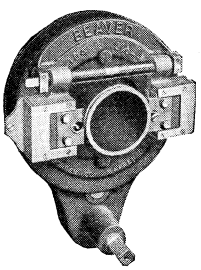


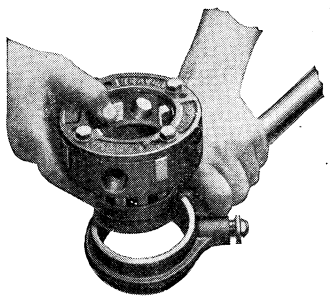
The New Beaver "4-Post" Die Stock No. 8, Plain — No. 8-R, Ratchet 1 to 2"—Semi-Self-Contained.



Bolt Die Heads for No. 3 Beaver Ratchet



The New No. 104 Beaver Square-End Cutter Fully Automatic & Self-Contained. 2½ to 4".



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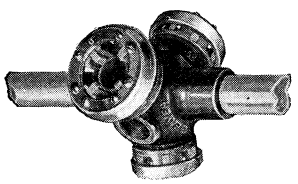

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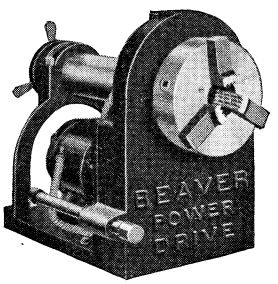

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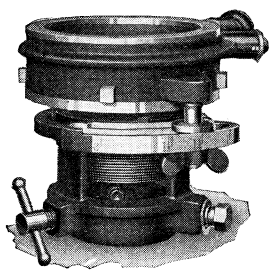

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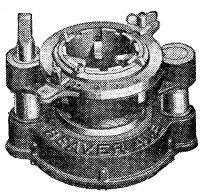

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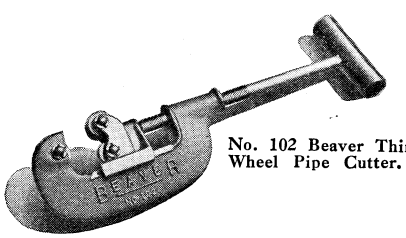

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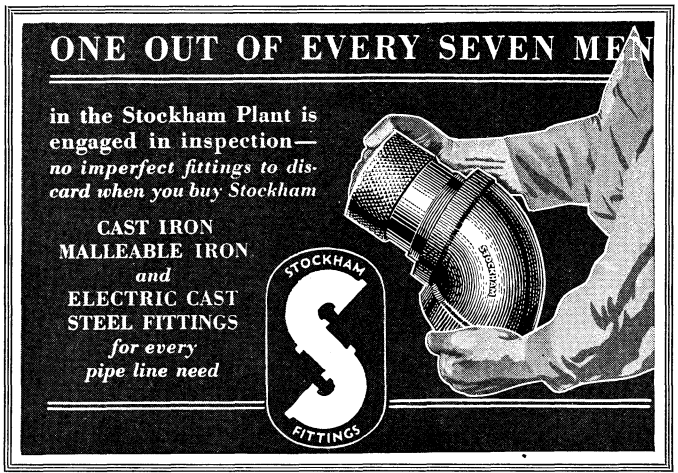

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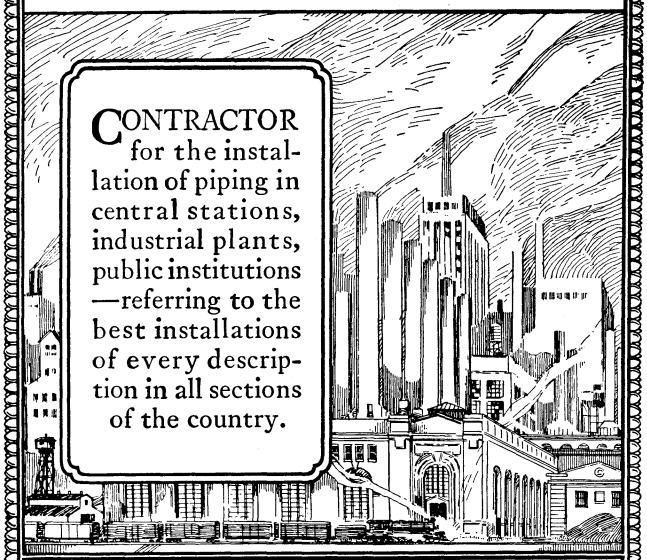

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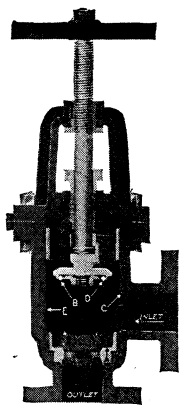

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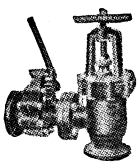

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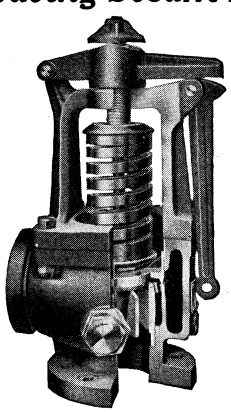

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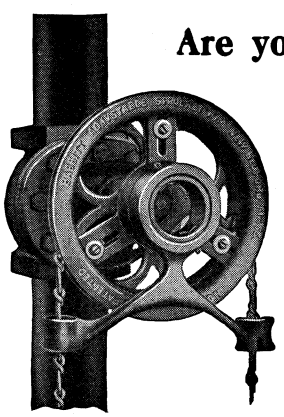

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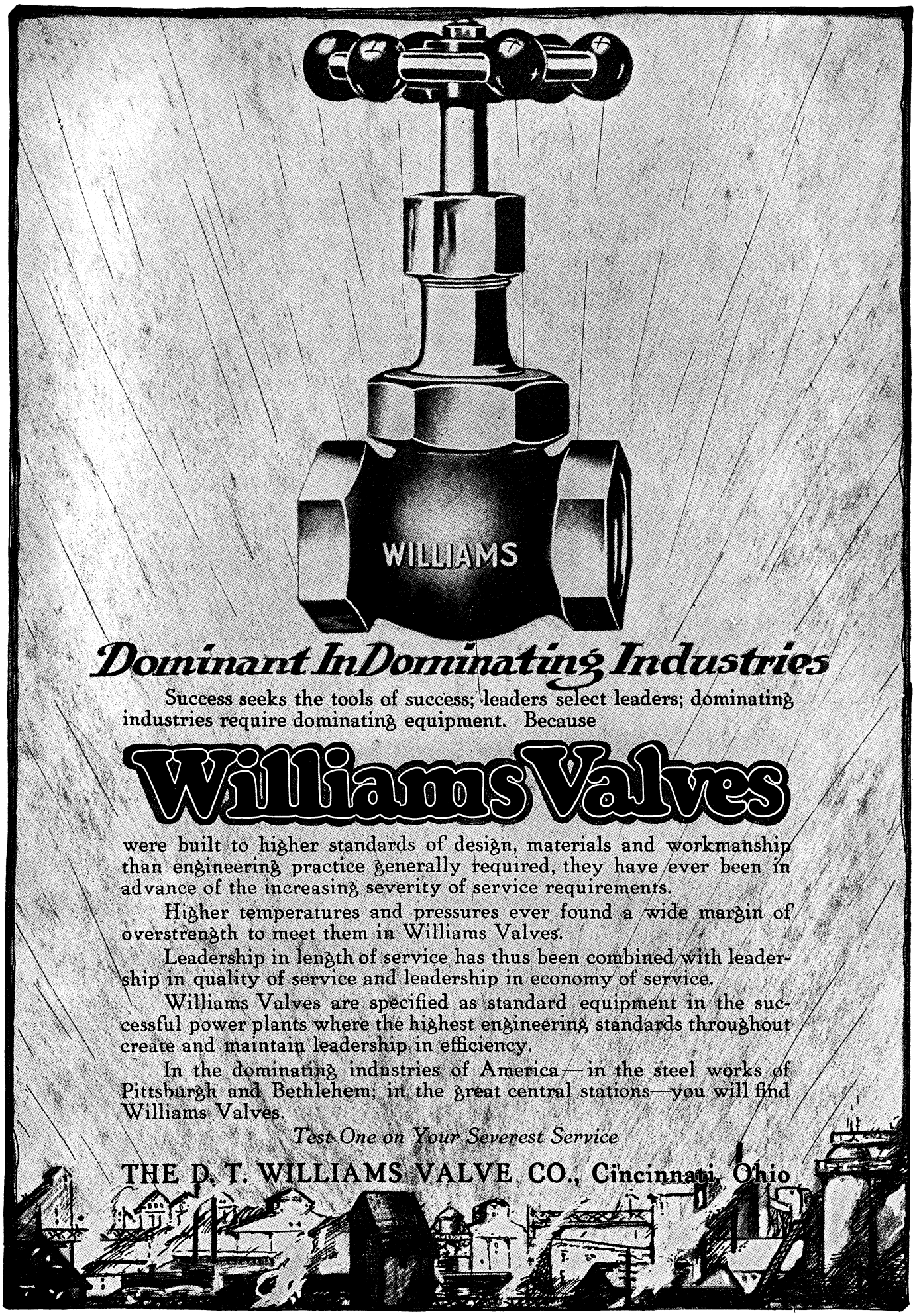

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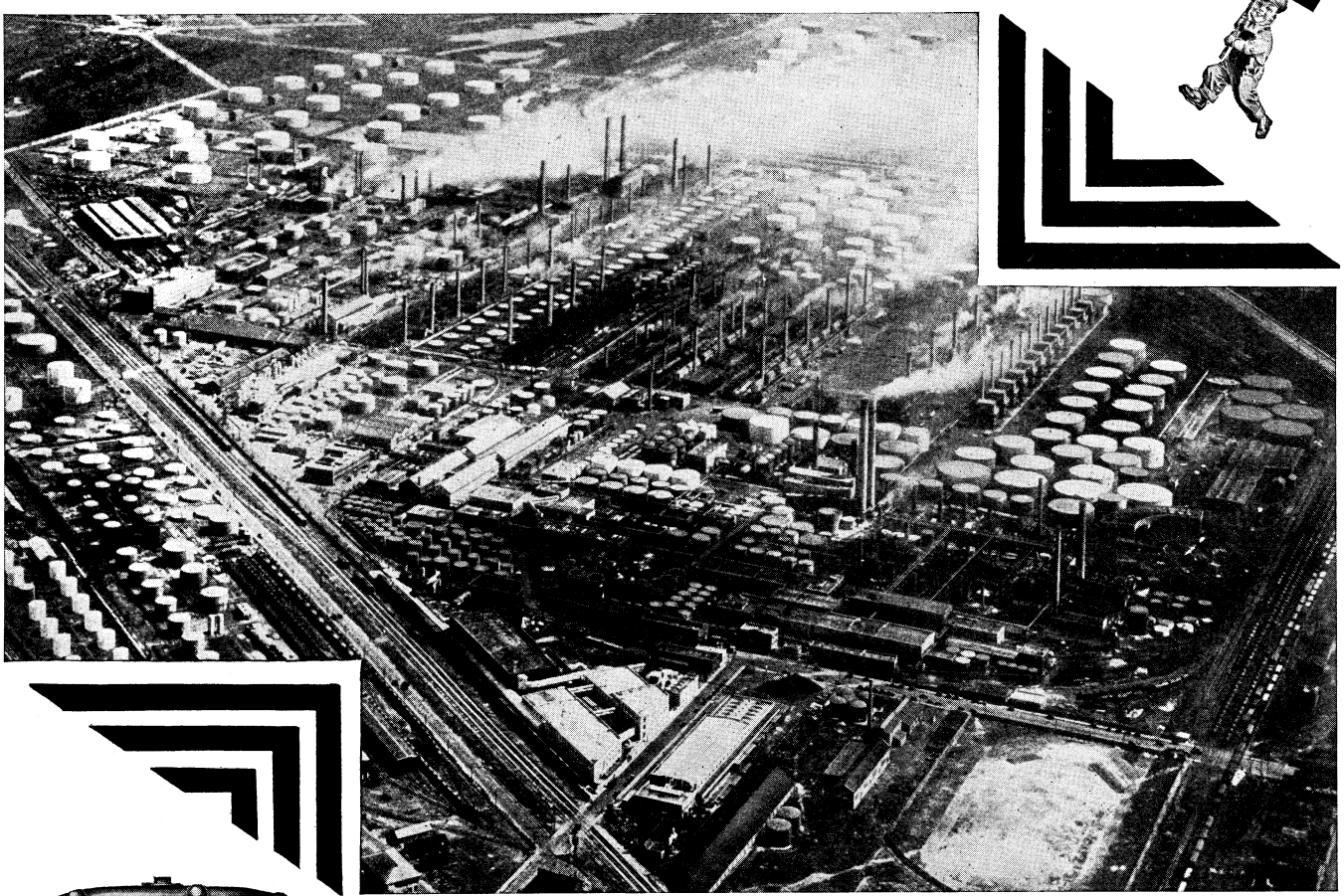

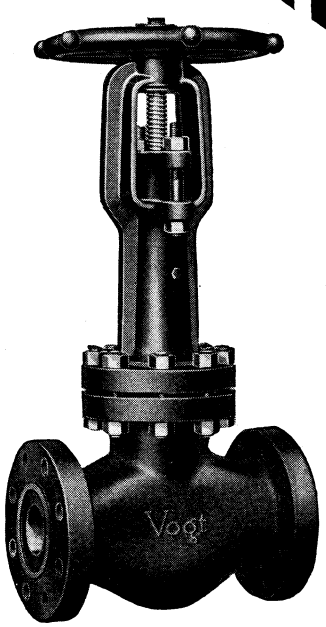

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FIGURE 106-A *with the one-piece screw-over bonnet and slip-on stay-on disc holder . . .*

THIS is the Standard Bronze Globe Valve that engineers are talking about. It is the Jenkins with the one-piece screw-over bonnet, and the slip-on stay-on disc holder.

The screw-over bonnet contributes great strength. Take the bonnet off and put it back repeatedly. It won't spring or distort . . . because it is made from a single piece of selected Jenkins bronze.

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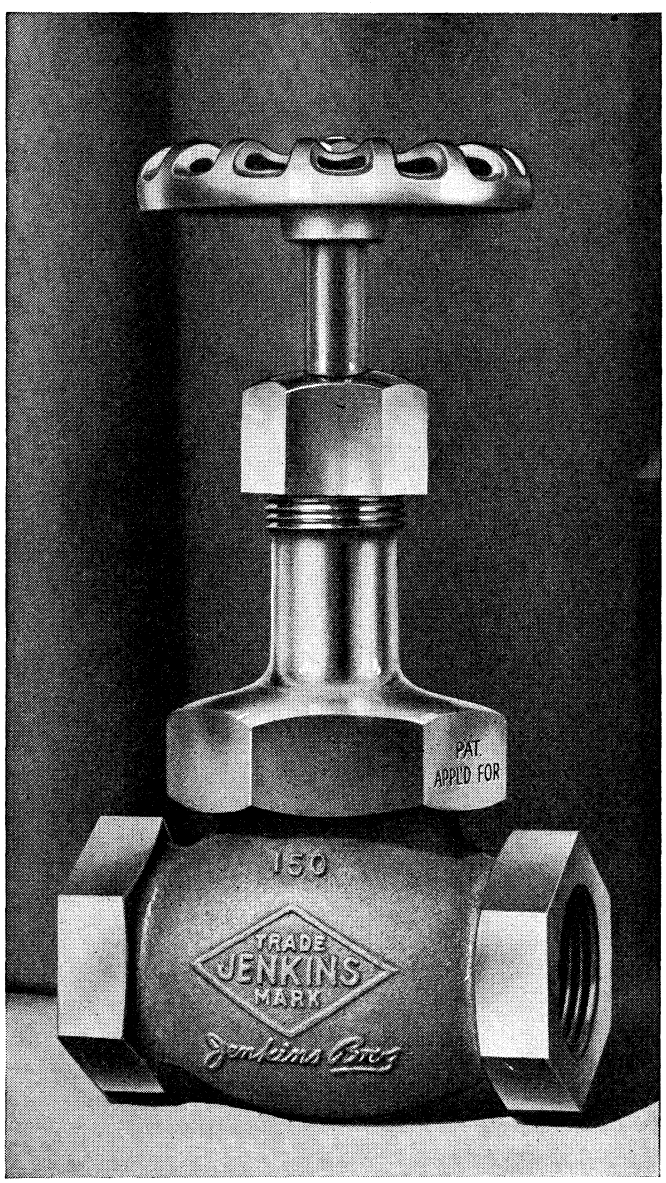
FIG. 106-A, *Screwed, Jenkins Standard Bronze Globe Valve, with one-piece screw-over bonnet, and slip-on stay-on disc holder. For 150 lbs. steam working pressure, or 250 lbs. oil, water, gas working pressure.*



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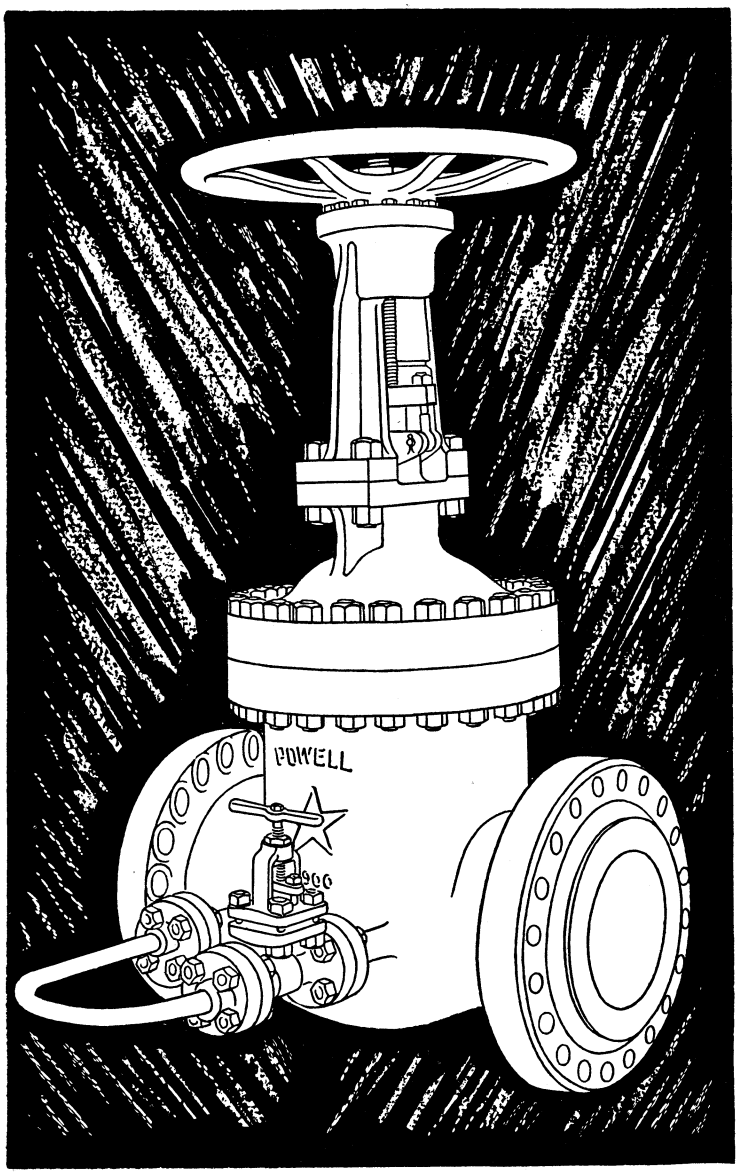

Fig. 9013
Series 900 Steel Gate Valve
with By-Pass

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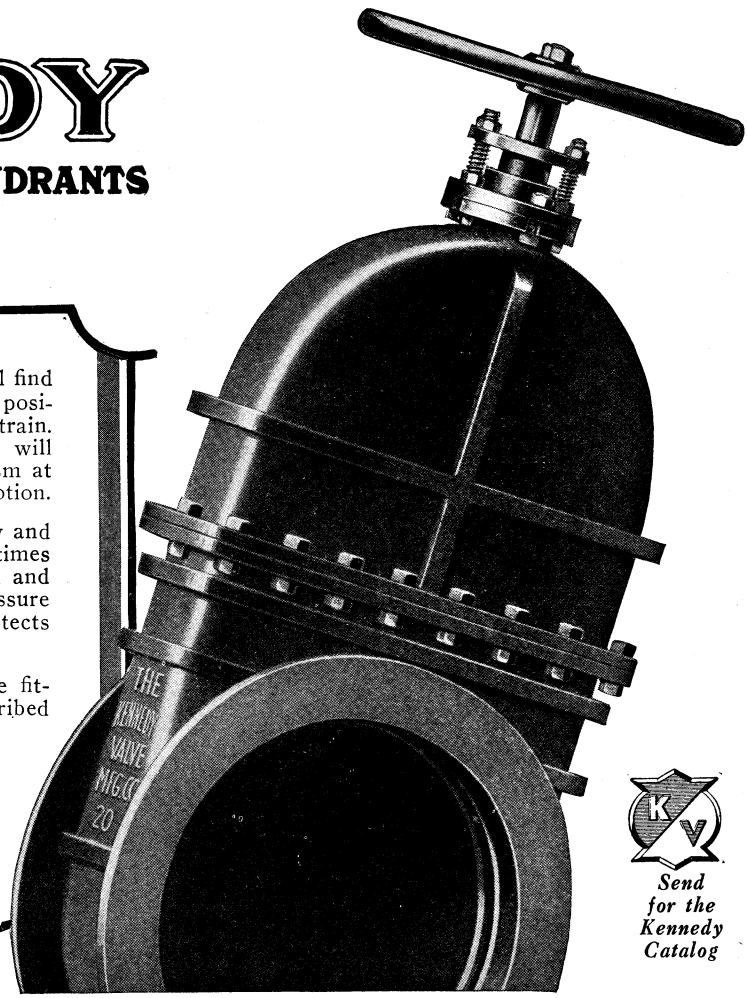

WHEN you close a Kennedy Valve, you will find ample leverage on the handwheel, smooth positive operation, and tight closure without strain. When the valve is to be opened again, you will find instant release of the operating mechanism at the first turn of the wheel and free easy motion.

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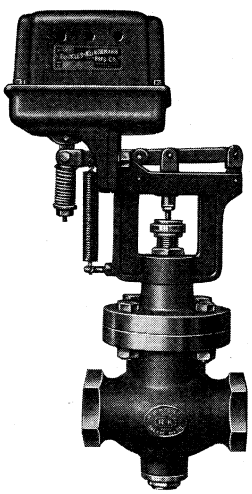

Fig. 240 Solenoid Operated Valves combine correct principles of design intended to give long life and reliable service under the most severe operating conditions.

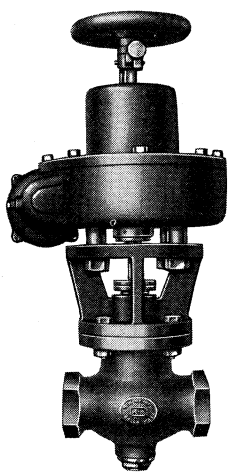

Fig. 246 Motor Operated Valves are of rugged compact design, embodying novel features of construction, which permit positive seating and unseating of valve without overloading of motor.

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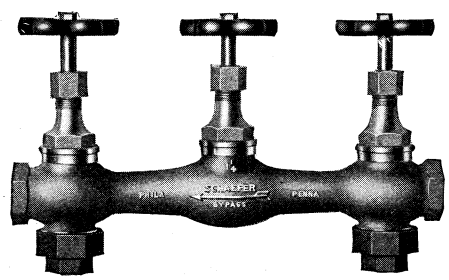

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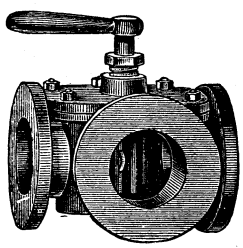

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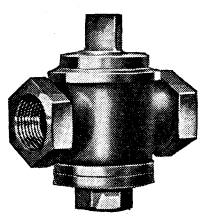

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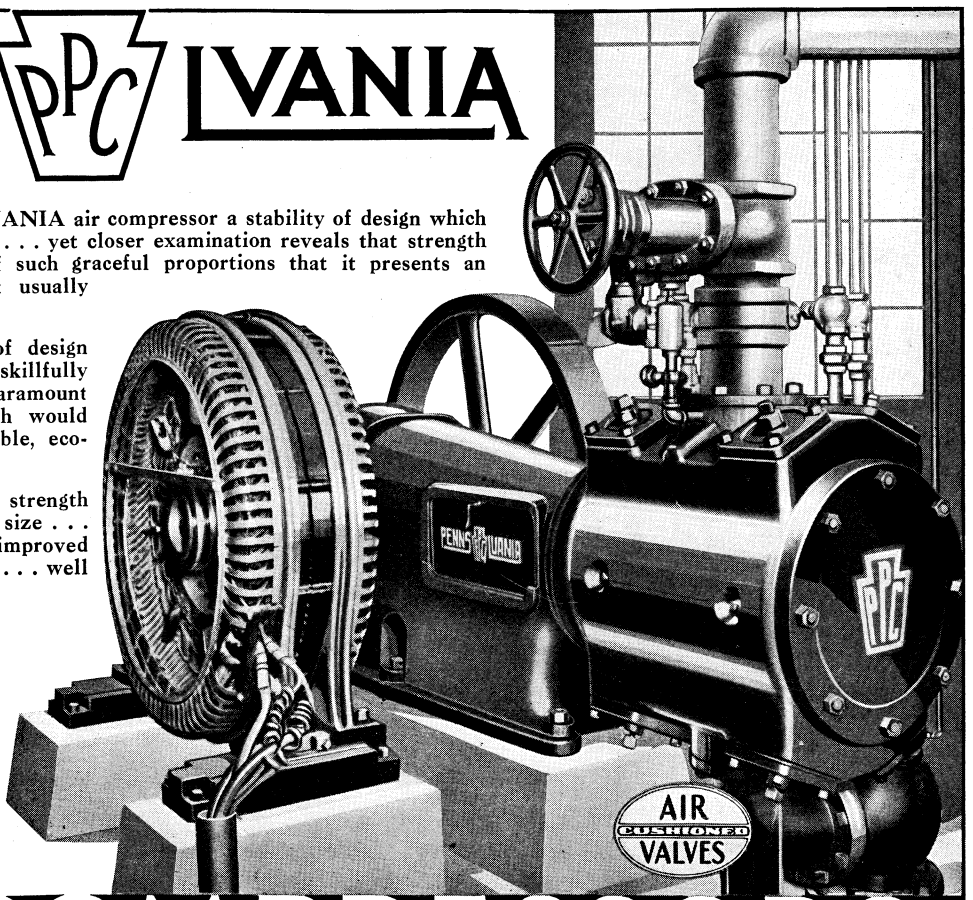

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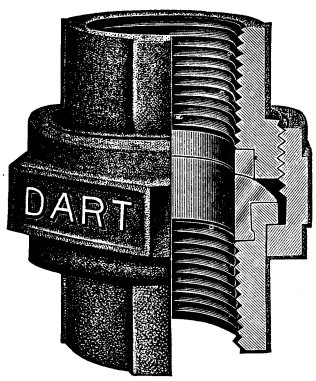

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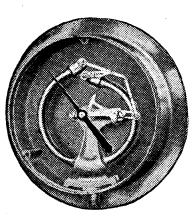

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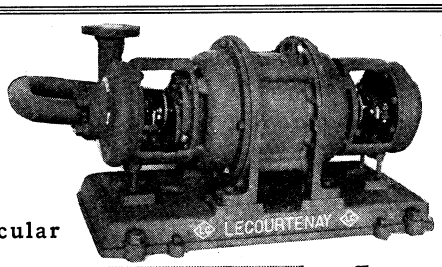

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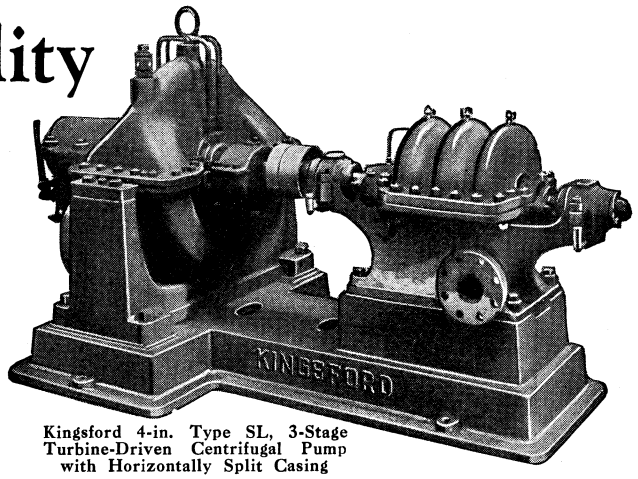

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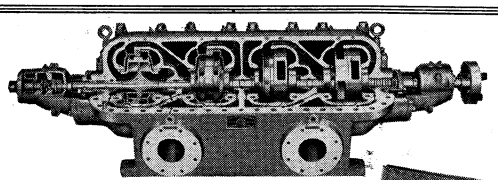
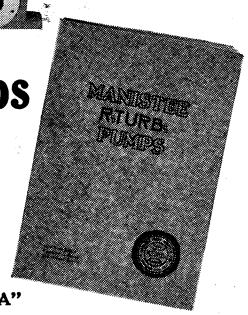


MANISTEE Pumps

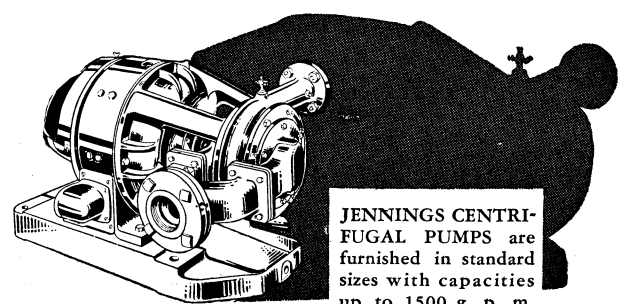
are characterized by unique design and sturdy construction that insure their high operating efficiency in America's leading industries. Write for catalog giving complete description.



Manistee Iron Works Co.

Chemical Evaporators — Air Pumps
Centrifugal Pumps

Manistee, Mich., U. S. A. Box "A"



Jennings Pumps

JENNINGS CENTRIFUGAL PUMPS are furnished in standard sizes with capacities up to 1500 g. p. m. Heads up to 300 ft. Write for Bulletin 128. The Nash Engineering Company, 169 Wilson Rd., S. Norwalk, Conn.

Continuous Service

As "infallible" as any man-made machine can be—designed especially for the exact job, with oversize parts and rugged construction throughout—each Frederick pump gives *continuous service* at the hardest heavy-duty! Investigate Frederick dependability. Consult our Engineering Department for details and recommendations on that new installation or replacement. *Write us!*

FREDERICK PUMPS

The Frederick Iron & Steel Co., Frederick, Maryland

Warren Pumps

WARREN

High grade centrifugal and reciprocating pumps for every power plant service. Designed, built and tested for years of dependable service at least cost for operation and maintenance.

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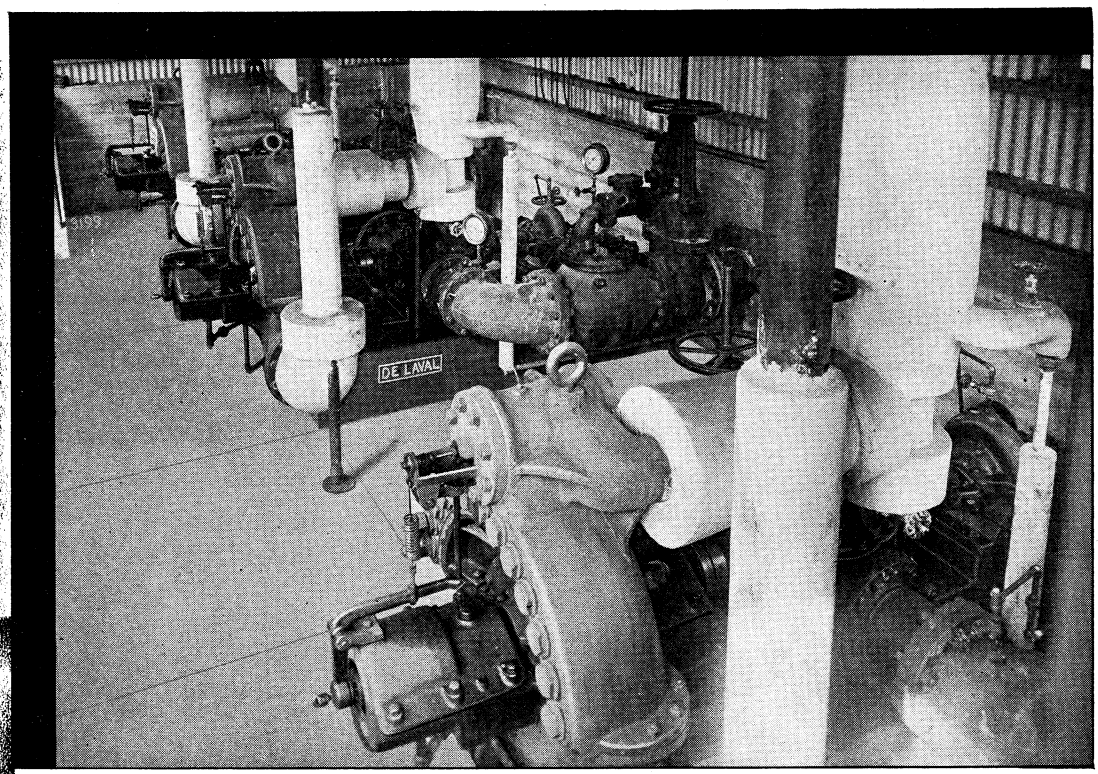
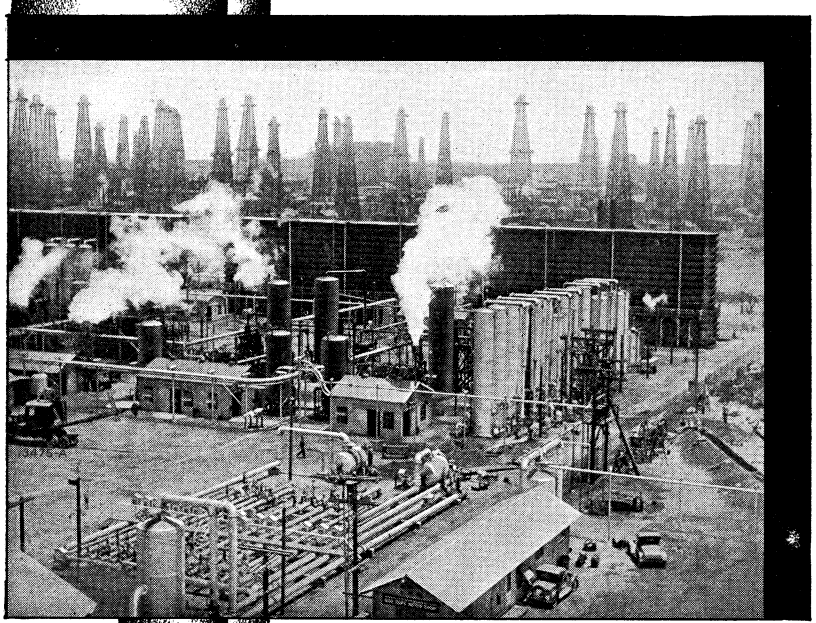
Warren, Mass.



DE LAVAL pumps and turbines for continuous operation . . . . .



WATER, oil and gasoline are kept moving throughout the World's largest natural gasoline plant by De Laval steam turbine driven centrifugal pumps.

The three units here shown consist each of a 50 hp. turbine receiving steam at 140 lbs. pressure and exhausting to the process at 30 lbs per sq. in., and directly connected to two pumps. One pump delivers 1500 gals. per min. of cooling water against 70 ft head, and the other 52 gals. per min. of .77 specific gravity gasoline at 90 deg. fahr., against 50 lbs. per sq. in.

By suitable adaptation of the several turbines and pumps the process is made substantially self-regulating.

High-class materials and workmanship and a limit gage, interchangeable system of manufacture insure uninterrupted production.

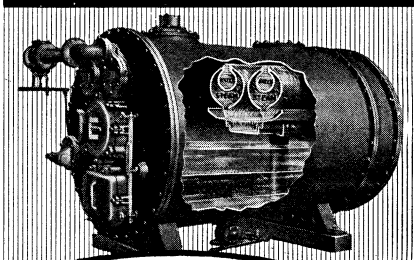
De Laval Steam Turbine Co., Trenton, N. J.

Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery

PACIFIC COAST OFFICES:—LOS ANGELES, 590 SUBWAY TERMINAL BUILDING
SAN FRANCISCO, 720 RIALTO BUILDING

3090

NATIONAL



Water as hot as exhaust steam—cost of upkeep less than you'd expect because the National

Direct Contact FEED WATER HEATER

has upward filtration. The filter material lasts longer—it cannot be carried to the pump.

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The National Pipe Bending Co. Est. 1883
160 River Street, New Haven, Conn.
BOSTON NEW YORK PHILADELPHIA

AMERICAN Chimneys

We build:

Meeting modern high over-rating requirements and other special problems, American Chimneys serve in plants in all parts of the world. Internationally known for boiler settings, linings for steel stacks, repairs and extension of chimneys. Write for catalogue. No charge or obligation for preliminary sketches and estimates.

- Radial Brick Chimneys
- Common Brick Chimneys
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- Linings for Steel Stacks
- Boiler Settings
- We repair and extend Chimneys
- We also install, inspect and repair Lightning Rods.

AMERICAN CHIMNEY CORP.
147 Fourth Avenue, New York, N. Y.
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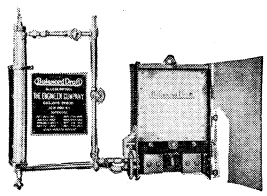
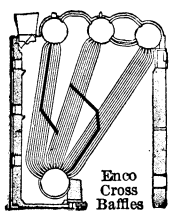
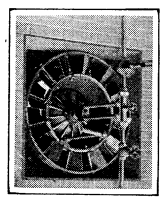


Enco Balanced Draft



Enco Cross Baffles



Enco S.A.R. Burner Unit

Enco Products

Enco Baffles for horizontal or vertical water tube boilers in combination with Enco Balanced Draft will greatly improve the operating efficiency and capacity of your boilers.

Enco Burners for oil or gas will lower the cost of steam when burning any of these fuels.

THE ENGINEER COMPANY
17 BATTERY PLACE NEW YORK

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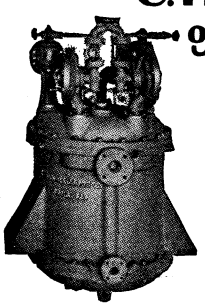

Surface Condensers, Jet Condensers, Barometric Condensers, Leach Fraste Control Condensers, Oil Vapor Condensers, Heat Exchangers, Ejector type Air Pumps for vacua up to 29.95 inches, Natural and Forced Draft Cooling Towers.

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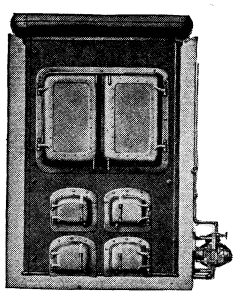
Motor—or Turbine—Driven



for making
MORE STEAM
MORE QUICKLY
MORE CHEAPLY
in boilers
Stokered or Hand-Fired

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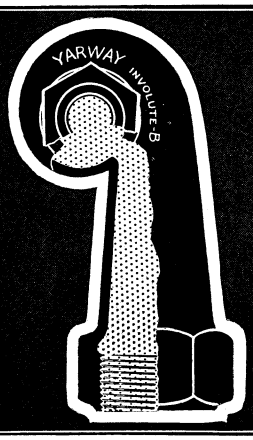

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No internal parts, vanes or deflecting plates to clog.

Minimum loss of head due to less internal friction.

Write for Booklet N-613 describing the comprehensive range of sizes and types.

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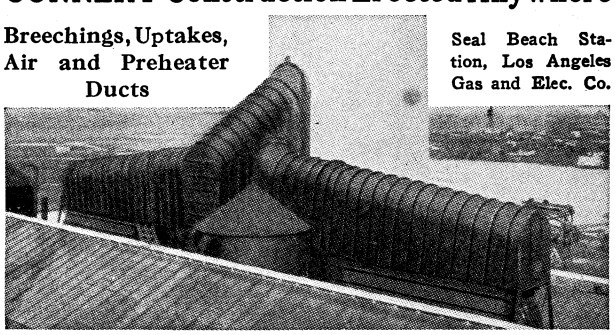

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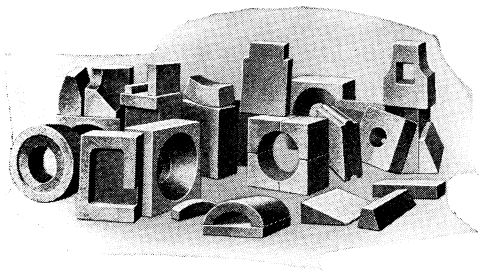

Make Your Own Special Shapes For Boiler Furnace Settings

Use Ganisand or crushed old firebrick, ground to pass ¼" mesh (including the fines) mixed with

HYTEMPITE

First mix HYTEMPITE with enough water to form a pancake batter. Then add refractory material gradually until the mass is stiff enough to be handled without showing any free moisture. Pound with a mallet or rammer into a wood or metal form to make Special Shapes or Tile.

Send for Booklet H-109 and the name of our local distributor.

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INDUSTRIAL SPECIALTIES
56 West 45th Street, New York
Distributors with Stock and Service in every Industrial Center

Quality and Uniformity

have made the merited reputation

DURA-STIX
FIREBRICK CEMENT

universally enjoys for extending the usefulness of firebrick in furnace construction.

It bonds through the entire thickness of the wall. Its strong, thin joint, is made stronger with heat. It is immune to temperature changes.

390 lbs. will bond 1000 standard size firebrick.

Useful information and data in our new Booklet E 31. Send for one.

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Representatives and Stock for immediate delivery in Industrial Centers.

"STEEL MIXTURE"
Furnace Linings and Arches

Complete boiler settings. Flat Suspended Arches and Walls. Boiler Door Arches. Fire Box Blocks. Air-cooled walls. Back Arches for h.r.t. Boilers. Blow-off Pipe Protectors. Standard Fire Brick. Baffle Tiles. Fire Cement.

Silicon-Carbide **CARBEX** *Super-Refractories*

Standard size Bricks, Cements, Door Jambs and Arches, for Boiler Furnaces. Special Shapes for Boiler and Heat Treating Furnaces. *Write for Booklet No. 29*

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Branch Offices: New York - Boston - Cleveland - Detroit
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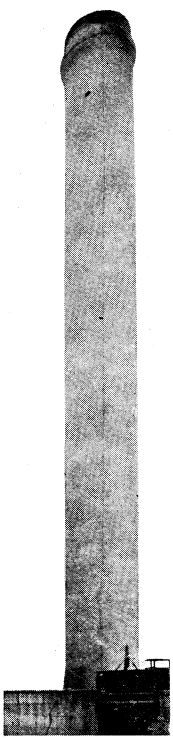
World's Largest Producer of Refractories PITTSBURGH, PA.



Concrete stack at the plant of Potomac Electric Power Co., Washington, D. C., restored with "Gunite." Work done by our Contract Dept.

—also when restoring stacks! Use the

CEMENT-GUN
TRADE MARK

This is another of the many uses of the "Cement-Gun" around the plant. The "Cement-Gun" method of restoring stacks has been highly successful throughout the country. Send coupon for bulletin. Our Contract Department will do your "Gunite" work for you.

Cement-Gun Company, Inc.
Allentown, Penna.

Cement-Gun Co., Inc., Allentown, Penna.
Please send us full information regarding the many uses of the "Cement-Gun" inside and outside the plant.

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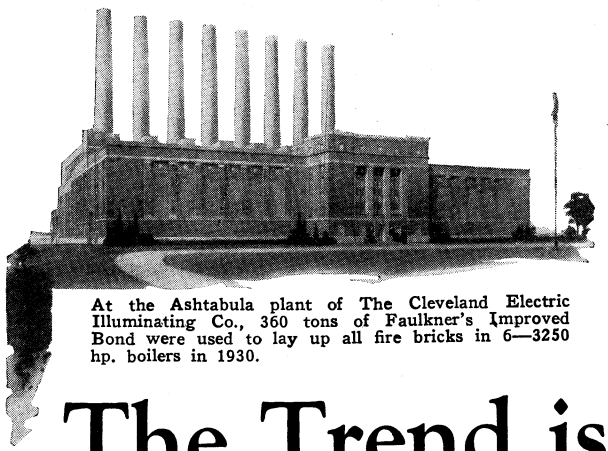
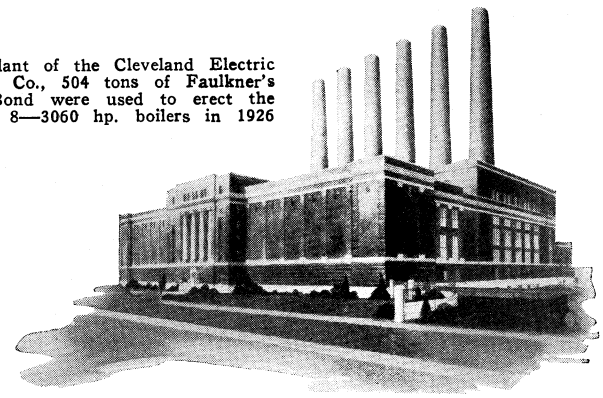


At the Ashtabula plant of The Cleveland Electric Illuminating Co., 360 tons of Faulkner's Improved Bond were used to lay up all fire bricks in 6—3250 hp. boilers in 1930.



At Avon plant of the Cleveland Electric Illuminating Co., 504 tons of Faulkner's Improved Bond were used to erect the settings for 8—3060 hp. boilers in 1926 and 1928.

The Trend is Toward FAULKNER'S *Improved* Bond

Some leading plants that have used one or more carloads of Faulkner's Improved Bond recently:

Milwaukee Electric Railway & Light Co.
Consolidated Gas, Electric Light & Power Co.
Columbus Railway & Electric Light & Power Co.
Columbia Power Co.
Ohio Edison Co.
Minneapolis General Electric Co.
Toledo Edison Co.
Atlantic Refining Co.
Standard Oil Co. of Ohio
Valvoline Oil Co.
Sun Oil Co.
International Harvester Co.
Ford Motor Co. Dearborn
Murray Body Co.
Jones & Laughlin Steel Co.
Sharon Steel Hoop Co.
Pressed Steel Car Co.
Newton Steel Co.
Curtis Aeroplane & Motor Co.
Western Electric Co., Point Breeze
Rust Engineering Co.
Geo. Allen & Son

Trade Mark Reg. U. S. Pat. Office

Shipped Dry
No Waste

Here are the Reasons for this Trend to Faulkner's Improved Bond.

1. **Contains No Vegetable Binder**—or other drying mediums that tend to creep out to the edges of the bond leaving the inner part free of any binder with consequent dusting and breaking of the bond.
2. **Sets Firm on Drying**—no high temperature vitrification required—sets itself when laid in.
3. **Does Not Make a "Weld" Bond**—forms an airtight bond but does not "weld" the bricks too tightly.
4. **Gains Strength as Heat Increases**—Intense temperatures only tend to improve Faulkner's Bond.

Specify Faulkner's Improved Bond for laying up fire bricks in all temperatures. During the five years prior to 1930 we furnished Faulkner's Improved Bond for the settings of 55,000 hp. of boilers.

In the past few months we have sold Bond for the erection of settings for 70,000 hp. of boilers. Faulkner's Improved Bond amounting to approximately fifty carloads has been used exclusively for all fire bricks in these settings.

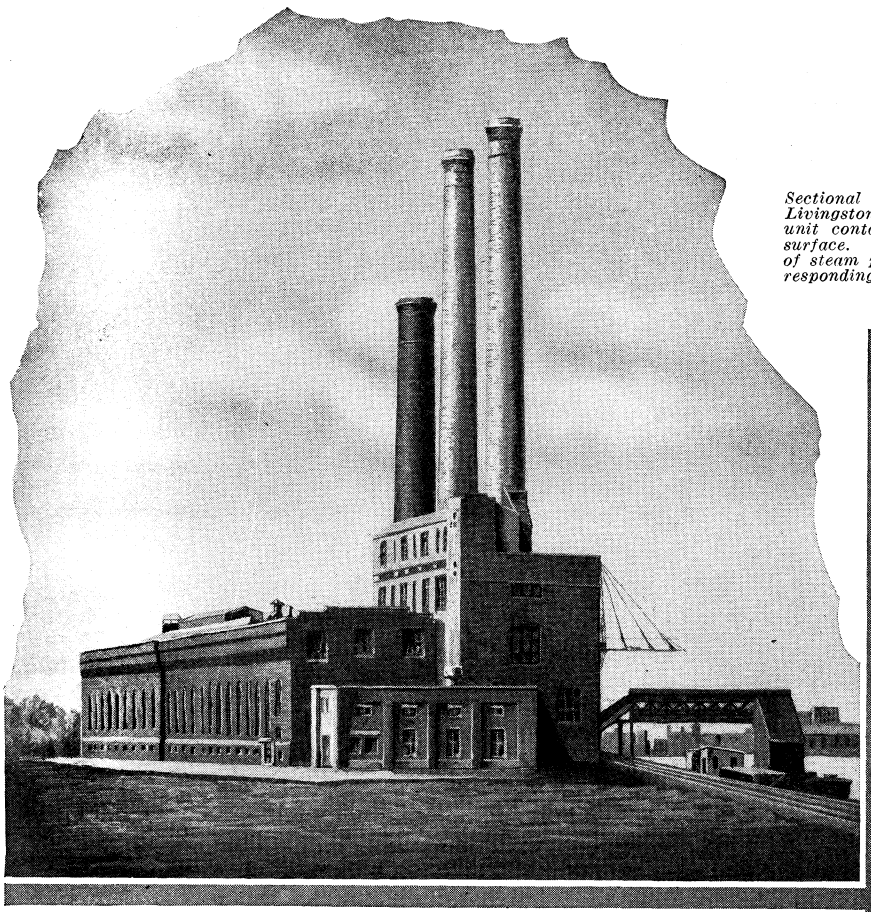
Faulkner's Improved Bond does not depend upon any mineral or vegetable binder for its initial set. It becomes firm on drying with sufficient bonding strength to hold the bricks in place.

This Bond bakes in the vertical and horizontal joints without shrinkage or expansion, to prevent the infiltration of cold air to the furnace. Will not dust out of the joints in any section of the setting, yet does not weld the bricks so tightly that they cannot move under varying degrees of heat.

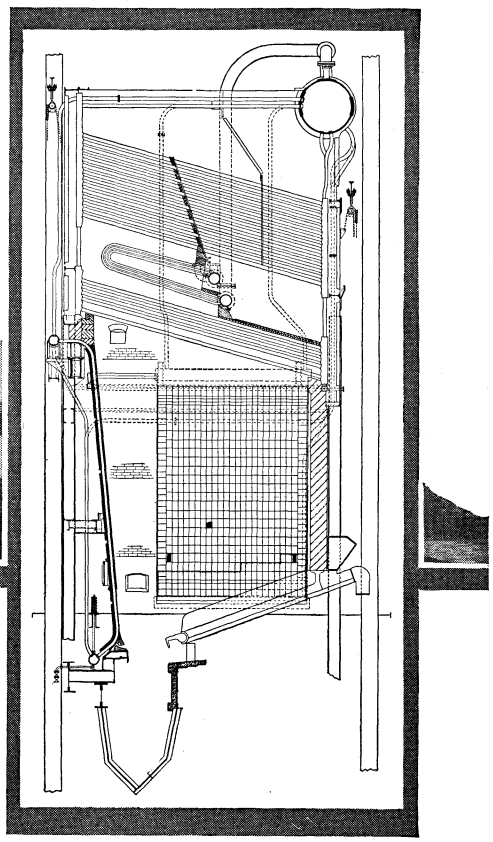
The price of Faulkner's Improved Bond is very reasonable. Let us quote on your next job, and put you in touch with our nearest representatives.

THE J. A. FAULKNER REFRACTORIES COMPANY

523 West Federal St., Youngstown, Ohio



Sectional elevation of Boiler No. 1 at Livingston Station, a Babcock and Wilcox unit containing 14,500 sq. ft. of heating surface. Designed capacity is 171,500 lb. of steam per hour at 310 lb. pressure corresponding to a rating of 400 per cent.



BAILEY FURNACE WALLS A GOOD INVESTMENT AT LIVINGSTON STATION

That Bailey Water-Cooled Furnace Walls are a good investment is evident from the operating records of many power plants. For instance, the following data from the Livingston Station of the Staten Island Edison Corporation, a unit of the Associated Gas & Electric Company's system.

Boiler No. 1—fired by an underfeed stoker—was equipped with Bailey bridge and side walls in August, 1927. The operation of this furnace was so satisfactory that within the following two years the refractory bridge walls of Boilers No. 2, 3 and 4 were replaced with walls of Bailey construction.

Day by day these Bailey Walls show profit on the investment due to reduced stoker and furnace maintenance, higher boiler efficiency—and a great increase in availability equaling one month per year for each boiler. Boiler No. 1 was out of service for furnace repairs only 6 days during the past two years. All boilers can now be operated at higher continuous ratings than was practical with the old settings.

Let a Fuller Lehigh Engineer tell you more about Bailey Walls—no obligation on your part.

FULLER LEHIGH COMPANY
A Babcock & Wilcox Organization
85 LIBERTY ST., NEW YORK, N.Y.

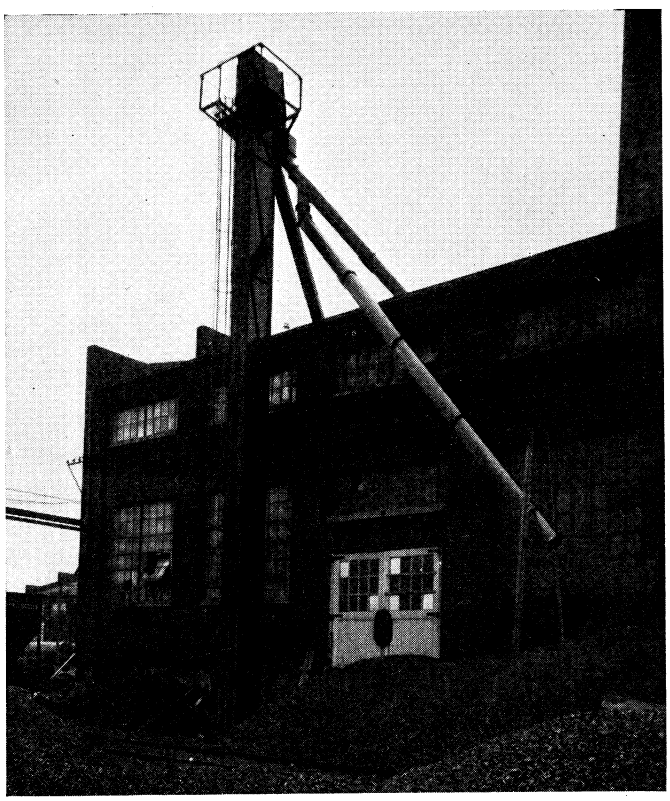
FULLER LEHIGH

PULVERIZED-COAL EQUIPMENT ~ WATER-COOLED FURNACE WALLS

177

THE FAIRFIELD WAY

REDUCING THE HIGH COST OF COAL HANDLING



To reduce coal handling costs to a minimum, the Niagara Sprayer Company, Middleport, N. Y., installed Fairfield equipment. The elevator distributes coal to inside bunker and to outside storage. A Fairfield engineer will gladly study your requirements. SEND US YOUR INQUIRIES.

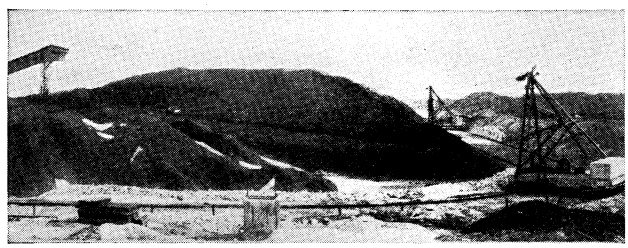
Write for Bulletin 35-1 P

The FAIRFIELD ENGINEERING CO.
MARION • • OHIO

Drag Scrapers for Coal Storage

Economical coal-handling systems for power plants of every size. Write for Catalog No. 11.

SAUERMAN BROS., Inc., 486 So. Clinton Street C H I C A G O



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FOR COLLECTION OF

COAL DUST
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DESCRIPTIVE BULLETINS ARE AVAILABLE

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CLEVELAND, OHIO

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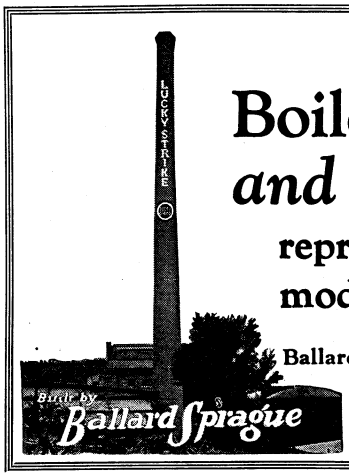
COMPLETE POWER PLANTS

THE RUST ENGINEERING CO.
PITTSBURGH, PA.
CHICAGO NEW YORK WASHINGTON BIRMINGHAM



Our
Boiler Settings
and Chimneys
represent the best modern practice

Ballard, Sprague & Company, Inc.
25 East 26th Street
New York

STEPHENS-ADAMSON MACHINERY

chosen again by St. Louis

Coal handling machinery designed and built by Stephens-Adamson engineers was specified and installed at the new Howard Bend Pumping Station operated by the city of St. Louis. This is the fourth large St. Louis pumping station to equip completely with S-A machinery. Power plant engineers recognize that unfailing dependability must be represented in every mechanical unit in these stations which furnish the water supply for this large city.

Your power plant like this municipal pumping station may be furnished with coal and ash handling machinery of S-A design especially devised for your particular requirements.

Write today for description of power plants equipt by S-A engineers

Stephens-Adamson Mfg. Co.
Main Office and Factory—Aurora, Illinois
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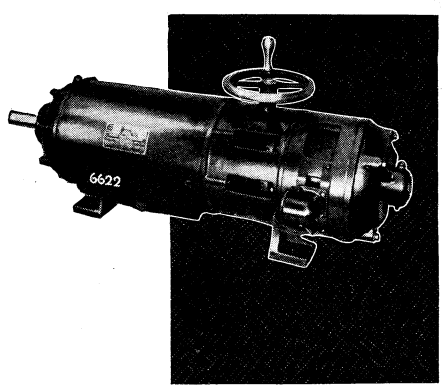
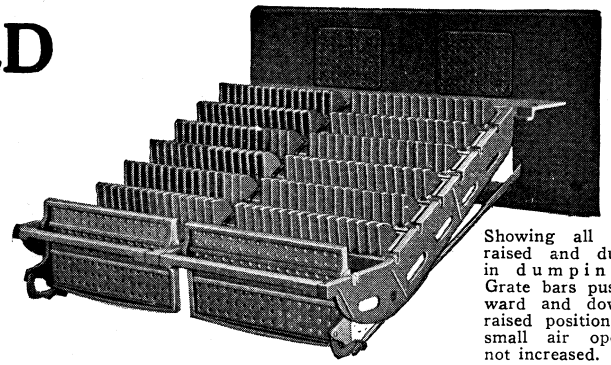
Now you can buy this self-contained, unusually compact electric power unit with thousands of operating speeds.



STEPHENS-ADAMSON

KELLY IMPROVED HAND STOKERS

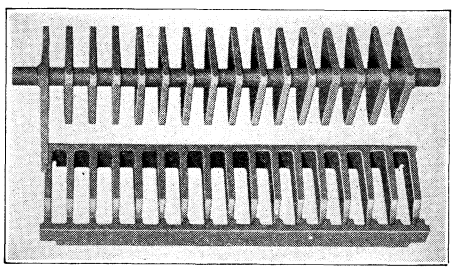


Showing all grate bars raised and dump plates in dumping position. Grate bars push fuel forward and down, yet in raised position the many small air openings are not increased.

SAVE from 10 to 15 per cent on the coal bills because they burn cheap grades of coal, as well as slack, screenings, refuse. Kelly Stokers insure a high rate of combustion. Operation of grates is by outside levers, the doors being opened to admit fuel only.

After 44 years of constant effort to produce grates for various services, Kelly is enabled to bring to power plants economical operation that makes an installation right under your present boilers a paying investment.

Investigate the Kelly line thoroughly. Write for complete information about these and other features which gain favor for Kelly Products with engineers.



Movable and stationary bars which mesh perfectly. No siftings of combustible.

The Kelly Foundry & Machine Co.
617 Ninth Street, Goshen, Ind.
POWER PLANT ENGINEERS
Established 1887

NEW YORK OFFICE: 53 Park Place
CHICAGO OFFICE: 178 W. Adams St.
PHILADELPHIA OFFICE: Bourse Bldg.

When you buy KELLY STOKERS-GRATES GOSHEN IND. *you buy results*

Easy to install

Easy to operate

Hand-Operated and Automatic **STOKERS**

NEEMES

Shaking and Dumping **GRATES**

Neemes Foundry, Inc., 186 First St., Troy, N. Y.

Established 1874 *Send for Bulletins* *Over 25,000 Installations*

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THE SUPERHEATER COMPANY
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AMERICAN
Improved Type "S"
ROLLING RING CRUSHER

Investigate the new all-steel Type "S" Crusher. It has such refinements as Timken Roller Bearings and Adjustable Grinding Plate. Its simplicity of design combined with solidity of construction insures long service and economic maintenance under severe conditions. Built to pass Tramp Metal.

Write for Bulletin today.

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"PENNSYLVANIA" *STEELBUILT*
COAL BREAKERS AND CLEANERS (Bradford Type)
HAMMERMILLS—ARMORFRAME CRUSHERS

"Pennsylvania" *STEELBUILT* Coal Preparation Machinery offers engineers and operators a wide selection of types and sizes, specialized for heavy, continuous service in Central Stations, Gas Works and industrial Power Plants.

POSITIVE TRAMP IRON PROTECTION
UNBREAKABLE STEEL CONSTRUCTION

Put your coal preparation problems up to us

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General Offices: Liberty Trust Bldg. Philadelphia
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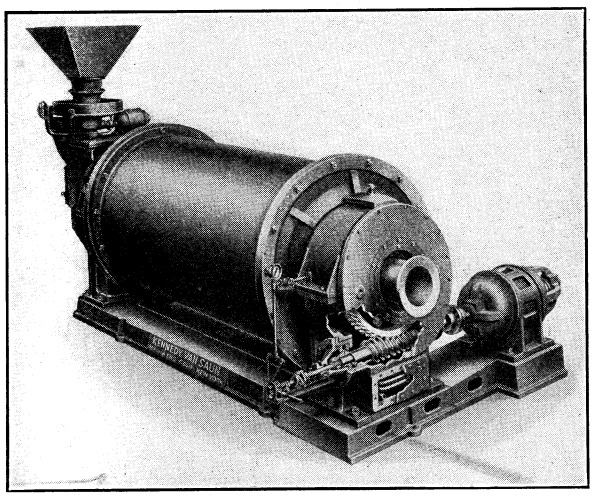
The Pulverizer With The Troubles Left Out



Kennedy Worm Driven Air-Swept Tube Mill.
Drive May be Either Horizontal or Vertical.

An Investment—Not an Expense

The following figures show the savings realized by the use of the KENNEDY AIR-SWEPT TUBE MILL SYSTEM, over the previous cost of stoker firing, by one of the largest concerns of the country. THE COST OF THE KENNEDY INSTALLATION WAS $21,242.00. The savings per year amounted to $17,959.00, or approximately 84.5%, which would amortize the cost in less than fifteen months, and thereafter produce an income of $17,-959.00 annually, OR A RETURN OF 84½ CENTS PER YEAR ON EVERY DOLLAR INVESTED. DOES ANY OTHER PORTION OF YOUR BUSINESS PRODUCE A RETURN OF THIS KIND ON CAPITAL INVESTMENT?

THINK IT OVER!

	STOKER FIRING	KENNEDY SYSTEM	SAVING
Cost of Coal.....	$32,700.00	$19,705.00	$12,995.00
Maintenance & Power	2,574.00	1,114.00	1,460.00
Labor	10,512.00	7,008.00	3,504.00
	$45,786.00	$27,827.00	$17,959.00

The present is an investors' and buyers' market, and NOW is the time to provide for future economy and income.
Catalogue 12-B, which describes this equipment, sent on request.

Kennedy-Van Saun Mfg. & Eng. Corp.,

No. 2 Park Avenue,
New York City

BRANCH OFFICES:—Chicago, 120 South La Salle St. Birmingham, Ala., Comer Building. Los Angeles, Calif., 414 South Spring St. London, England, Bush House. Paris, France, 40 Rue des Mathurins. Johannesburg, S. Africa, 73 Cullinan Bldg. Canadian Agents, Canadian Fairbanks-Morse Co., 980 St. Antoine St., Montreal, Que. Walkers Limited, Maryborough, Queensland, Australia. Cuban Agents, Gerard Jansen Y Cia, Compostela 43, Havana, Cuba.

BURNERS
for
Oil—Pulverized Coal—Gas

BURNERS
PEABODY

Our bulletin 601 contains valuable information. Send for it.

Peabody Engineering Corporation
295 Madison Ave. New York

SPRINGFIELD
BOILERS—WATER WALLS
SECTIONAL—ALL STEEL
ALL SIZES—ALL PRESSURES

Repeat orders constitute the largest part of our business

SPRINGFIELD BOILER CO.
SPRINGFIELD, ILLINOIS

UNIPULVO
UNDERFED UNIT FUEL PULVERIZER

For all boilers—150 H. P. up, using any bituminous coal, lignite, petroleum coke, pitch or charcoal.

THE STRONG-SCOTT MFG. CO.
Minneapolis, Minnesota

CONTINUOUS UNRESTRICTED CIRCULATION
BADENHAUSEN-THE WORLD OVER

Remarkable Efficiencies
Shown by
BADENHAUSEN (Patented)
BOILERS
Preheaters
Superheaters
Water Cooled Furnace Walls

Each a unit in itself, yet an integral part of the boiler proper
Surveys and Tests by outside Engineers forwarded on request

BADENHAUSEN CORPORATION
General Office and Works
Cornwells Heights, Bucks County, Pa.

over $3,000.00 saved monthly

Prior to the installation of Detroit Stokers the cost of producing heat alone in the Deshler-Wallick Hotel and American Insurance Union Office Building in Columbus, Ohio, in a representative month—February, 1929—was as follows:

Fuel cost	$6,600
Firemen	800
Total	$7,400

After the installation of Detroit Stokers under three 415 H. P. boilers serving both users jointly, the comparable cost in February, 1930, was as follows:

Coal	$3,380
Firemen	400
Total	$3,780

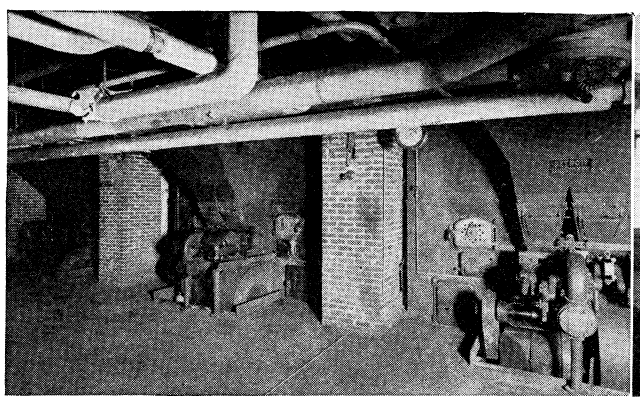
SAVING - - - - $3,620

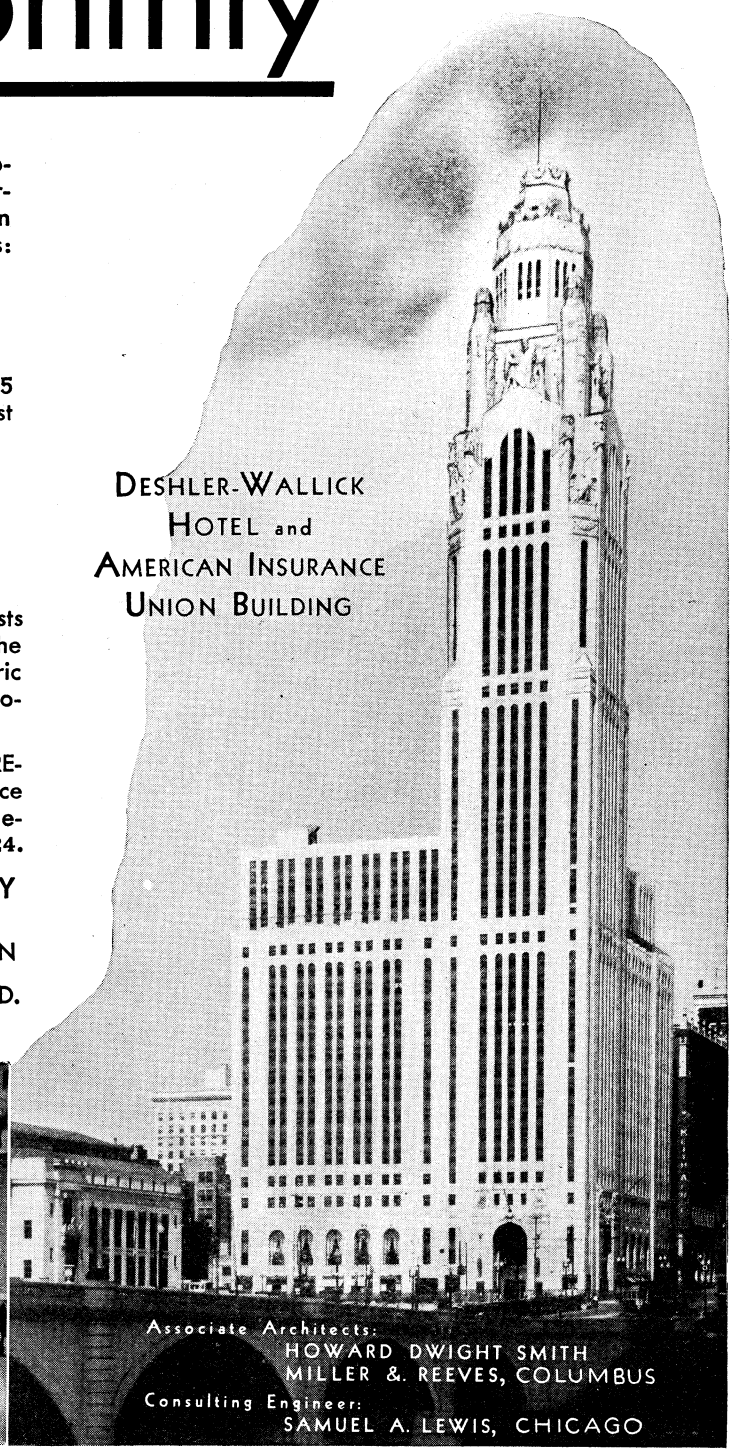
This saving of over $3000 a month applied to heating costs only. A further economy was effected subsequent to the installation of Detroit Stokers, through the use of electric generators, production of which amounted to 200,000 kilowatt-hours during February, 1930.

These economies were effected with Detroit DOUBLE RETORT Stokers—side cleaning stokers, built for heavy service and capable of carrying continuous high ratings. For detailed information on these stokers request Bulletin 424.

DETROIT STOKER COMPANY
THIRD FLOOR, GENERAL MOTORS BLDG.
DETROIT - - - MICHIGAN

In Canada: DETROIT STOKER COMPANY OF CANADA, LTD.
WINDSOR, ONTARIO





DETROIT STOKERS

Taylor Stokers

for preheated air . . .

The development of the long Taylor Stoker provides a means of fully realizing the advantages of high efficiency and high fuel-burning capacity resulting from the use of preheated air.

Preheated air speeds up the burning process, helps to dry out green coal; increases the relative area of most active combustion in the stoker fuel bed; assists in the distillation of the volatile gases; helps to bring the coked coal to the ignition point; reduces the loss of combustible in the ash and permits of operation with very low percentages of excess air. All these advantages are "plus" values in addition to the recovery of heat from the flue gases.

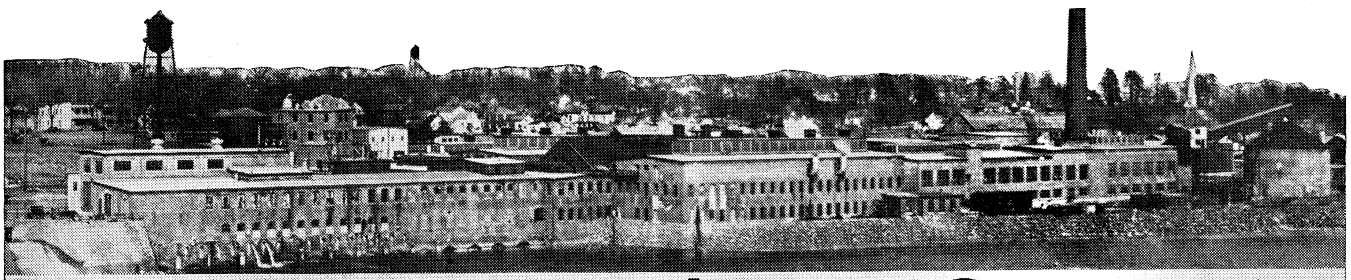
This list of preheated air installations should be conclusive evidence of the ability of the Taylor Stoker to operate with combustion air at any desirable degree of preheat. For information about the features of design that have made this possible, write for our booklet "New Horizons in Coal-Burning." It is filled with data on such important new stations as "Delray", "Edgar", "Genoa", "BEWAG", "Beacon Street" and others now under consideration.

TAYLOR PREHEATED AIR INSTALLATIONS

COMPANY	Size of Boiler B. H. P.	Max. Tem. Deg. F. that has Been Used
De Laval Steam Turbine Co., Trenton, N. J.	421	310
Packard Motor Car Co., Detroit, Mich...	1165	450
Ball Brothers Co., Noblesville, Ind.	796	240
Ball Brothers Co., Noblesville, Ind.	507	400
City of Fremont, Fremont, Nebr.	600	215
Anglo-Canadian Pulp & Paper Mills, Ltd., Limoilu, Quebec, Canada	1253	350
Michigan Alkali Co., Wyandotte, Mich...	1200	300
Lynn Gas & Electric Company, Lynn, Mass.	1580	350
Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.	1000	350
Iowa-Nebraska Light and Power Co., Norfolk, Neb.	480	340
London Power Co., Deptford East, London, Eng.	988	215
Viscose Company, Lewistown, Pa.	1000	300
Champion International Co., Lawrence, Mass.	552	450
International Harvester Co., Chicago, Ill.	500	315
City of Rochester, Rochester, Minn.	600	400
Detroit Edison Co. (Delray No. 3, Station), Detroit, Mich.	2500	350
Iowa Railway and Light Corporation, Cedar Rapids, Iowa	725	350
Pennsylvania Electric Co., Seward, Pa.	1600	225
Consumers Power Co., Zilwaukee, Mich.	928	175
Consumers Power Co., Zilwaukee, Mich.	1234	400
Riverside Power Manufacturing Co., Iowana, Iowa	1044	250
Philadelphia Electric Co. (Chester)	1421	350
Philadelphia Electric Co. (Chester)	1421	500
Philadelphia Electric Co. (Richmond)...	1569	350
Penn Central Light and Power Co., Saxton, Pa.	1100	210
Potomac Electric Co., Washington, D. C.	1370	350
St. Maurice Valley Corporation, Shawinigan Falls, Quebec, Canada	1000	430
Peoples Gas & Electric Co., Mason City, Iowa	527	280
Peoples Gas & Electric Co., Mason City, Iowa	874	275
Ohio Edison Co., Springfield, Ohio	1250	310
Fort Frances Pulp and Paper Co., Ltd., Fort Frances, Ontario, Canada		400
Edison Electric Illuminating Co. (Edgar Station), Boilers #7 and #8, Boston, Mass.	1509	500
American Salpa Corporation, East Spotswood, N. J.	556	250
Edward Ford Plate Glass Co., Rossford, Ohio	1200	320
Iowa-Nebraska Light and Power Co., Lincoln, Neb.	1050	350
Procter & Gamble Co., Baltimore, Md...	547	350
Western Electric Co., Baltimore, Md.	1305	350
	710	350
Packard Motor Car Co., Detroit, Mich...	1165	450
City of Hamilton, Hamilton, Ohio	500	300
Barrett Co., Elizabeth, N. J.	504	350

AMERICAN ENGINEERING

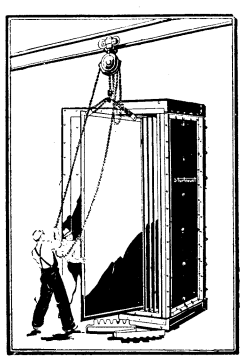
AMERICAN ENGINEERING COMPANY, 2408 ARAMINGO AVENUE, PHILADELPHIA



At the International Paper Company...

...these Air Preheaters present no Cleaning Problems

In the mill of the International Paper Co. at Fort Edward, N.Y.... 14,904 square feet of Sturtevant recuperative heating surface.



Cleaning...that common bane of air preheater operation...is a matter of slight concern here. Records prove cleanings are few and far between, with Sturtevant Air Preheaters.

The reason is quite simple. Gas passages in the Sturtevant recuperative plate-type Air Preheater are straight, and unusually large...several times larger than those in regenerative types. Seldom do they accumulate any appreciable amount of fly ash or soot...yet even when they do, ready access to the chambers makes cleaning a quick and easy job. Sturtevant provides no built-in mechanical cleaning apparatus. None is needed.

Nor are there any moving parts on Sturtevant Air Preheaters. There is nothing to require continual maintenance or cause air leakage. Operation excludes the human element.

There are other Sturtevant features that you will find to be of interest... notably *double-lived* removable and reversible chambers that cut corrosion costs in half. Full information available at the nearest Sturtevant office.

B. F. STURTEVANT COMPANY

Main Offices: HYDE PARK, BOSTON, MASS. CHICAGO, ILL., 410 No. Michigan Ave.. SAN FRANCISCO, CAL., 681 Market St. *Branch Offices in Principal Cities:* Canadian Offices at Toronto, Montreal and Galt. Canadian Representative Kipp Kelly, Ltd., Winnipeg. Agents in Principal Foreign Countries.

Sturtevant (REG. U. S. PAT. OFF.) *Air Preheaters*

BUSINESS IMPROVEMENT
will bring keen competition
CAN YOU MEET IT?

IF YOU expect to survive and make money, you will be forced to adopt every proven economy measure.

Wherever steam generating costs are a major expense item, fuel saving or capacity increase from existing equipment will have to be developed to the commercial limit.

In producing steam, the one remaining weak spot in the heat utility cycle is excessive loss to the stack. Right here is where plants operating at moderate to high load and use factors have their best opportunity. Through the use of a Ljungström Preheater and return to the furnace as preheated combustion air, 70 per cent of the heat otherwise passing up the stack is recovered and is made **more valuable** than equivalent heat produced from additional fuel.

The Ljungström Preheater is so simple, so small, so efficient that its low initial and operating costs are completely repaid in from one to two years, and thereafter, **with all fixed charges wiped out,** the continuing high net cash return invariably makes a sweet spot on each year's balance sheet.

Only Ljungström quick-acting heating surface and the exclusive Ljungström continuous regenerative counterflow principle permit maximum heat recovery with maximum commercial profit, so the Ljungström Preheater should be the first considered.

Substitute waste heat recovery and preheated combustion air for cold air and get these very profitable benefits

Recovery and profitable utilization of 70 per cent of the heat otherwise wasted to the stack.

A saving of from 200 to 300 lb. of every ton of fuel burned, without decrease in steam production—or 10 to 15 per cent more steam without burning more fuel or adding more boilers.

Faster steaming rate (greater boiler capacity) with greatest improvement during the peak periods when most needed.

Thorough combustion. Less unburned combustible lost to the ash and in the stack gas.

Faster combustion rate, with correspondingly greater capacity from furnace and fuel-burning equipment.

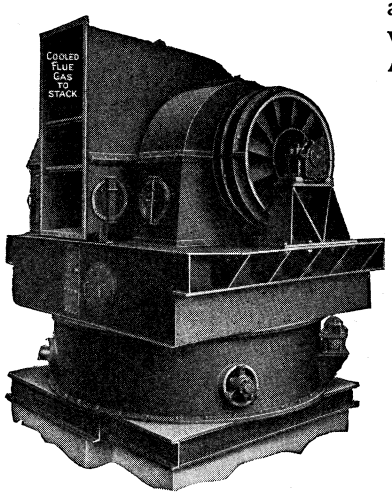
Combustion completed in the furnace. Less solids and tarry matter deposit among the tubes to check heat transfer and increase cleaning expense.

Greater and quicker heat extraction from wet or other low grade fuels, with ample steaming rate from cheaper fuel or enormous capacity increase without enlargement of heating surface, furnace or stoker equipment.

Smoother boiler operation and better heat utilization under all service conditions.

Greater economic improvement with higher boiler pressures, which otherwise increase the heat losses.

On request and without charge, our Engineers investigate existing plants, co-operate in new design or remodeling, explain possible improvement, and submit trustworthy performance figures which are easily verified and which we cover with binding guarantee. Ask at least for the Ljungström booklet.

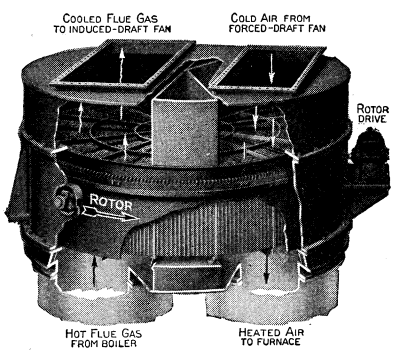


Type CAN Ljungström Air Preheater with Integral Forced-draft and Induced-draft Fans.

The scroll fan housings in connection with axial fan wheels greatly increase fan capacity and decrease operating power requirements.

Built also in vertical and horizontal types for use with independent forced-draft and induced-draft fans. The horizontal type handles flue gas temperatures up to 1800 deg. Fahr.

Over 800,000 boiler hp. of Ljungstrom Air Preheaters in use in the U. S. A.



Type CANX, for use with independent forced-draft, and induced-draft fans.

THE AIR PREHEATER CORPORATION
40 E. 34th St., New York

Works: Wellsville, New York, Agents in

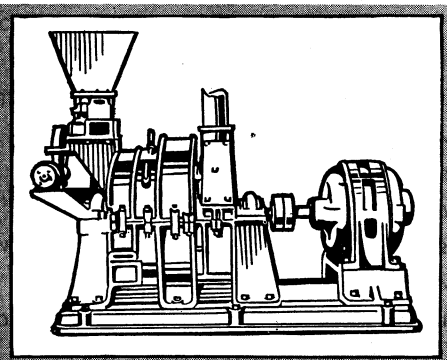
Boston	Charlotte	Cleveland	St. Louis	Pittsburgh	Houston
Buffalo	Denver	Philadelphia	New Orleans	Cincinnati	Los Angeles
Chicago	Detroit	Minneapolis	San Francisco	Kansas City	Tacoma

Canada: Lammers & Maase, Ltd., Montreal and Vancouver

Ljungström AIR PREHEATER

REG. U.S. PAT. OFF.

CONTINUOUS REGENERATIVE COUNTERFLOW

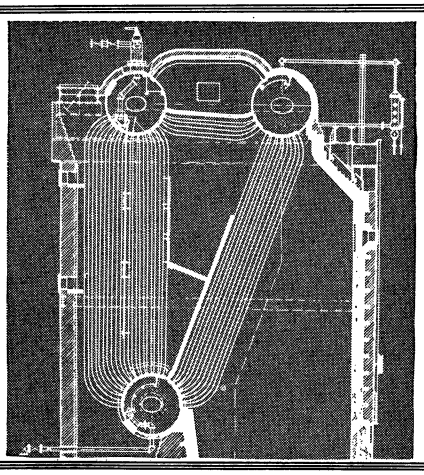


The ERIE CITY UNITYPE

A Pioneer of Unit Pulverizers

has served Industry for 10 years

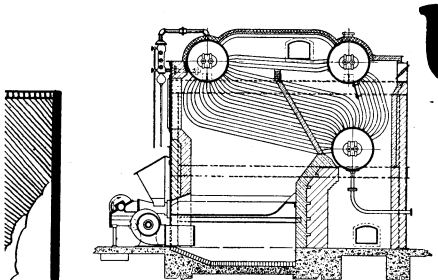
ERIE CITY IRON WORKS, Erie, Penna.



AN EXCEPTIONALLY EFFICIENT THREE DRUM BOILER
Because It Is Equipped With
THE CONNELLY THERMO-WATER STABILIZER
(Patents Pending)

THIS new Connelly design feature gives 100% water-heating surface, insures an exceptionally high efficiency, prevents burning and warping of tubes and makes for many other operating efficiencies. Built in units up to 15,000 square feet of heating surface and for pressures up to 600 lbs.

THE D. CONNELLY BOILER COMPANY
1170 Ivanhoe Road Cleveland, Ohio
BOILER SPECIALISTS FOR 56 YEARS



UNION TYPE E BOILERS

CAPACITY EFFICIENCY

a modification of the standard UNION 3-drum vertical bent tube boiler
FOR RESTRICTED SPACE INSTALLATIONS
—UNRETARDED CIRCULATION—FREE STEAM LIBERATION—DRIER STEAM—NO INACTIVE HEATING SURFACES

UNION IRON WORKS
ERIE, PA

WICKES BOILERS

Horizontal Cross Drum Boilers
Vertical Water Tube Boilers
Inclined Curved Tube Boilers
Horizontal Tubular Boilers

THE WICKES BOILER CO
SALES OFFICES:
NEW YORK, 501 FIFTH AVE. PITTSBURG, 1218 EMPIRE BLDG. SAGINAW, MICH.
CHICAGO, 33 SO. CLARK ST DETROIT, 2357 UNION TRUST BLDG.

Water Tube Boilers for Every Service

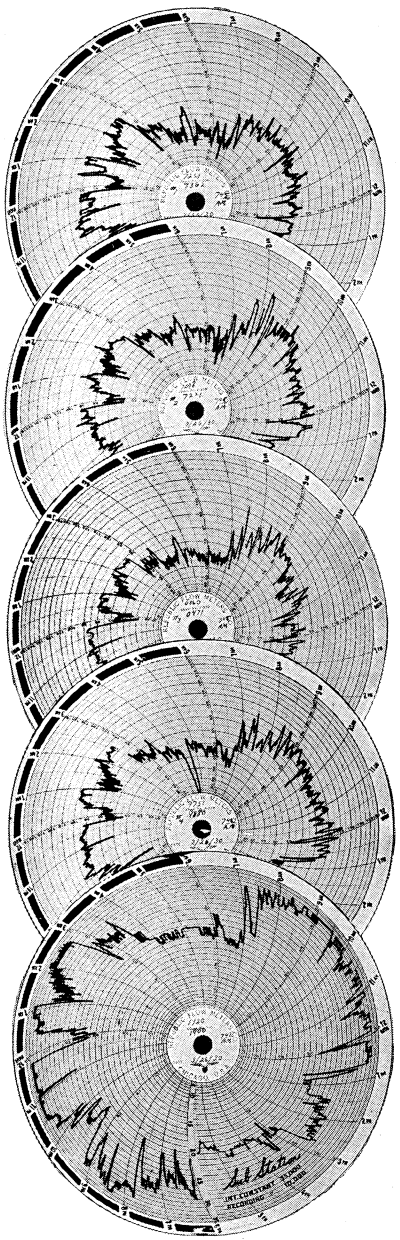
BOILERS of high quality for central stations and industrial plants of all sizes, and for utilization of waste heat from kilns and furnaces. Steel construction only. Straight tube and bent tube types. Noted for long life and economy of operation.

Engineering service available—wire or write.

EDGE MOOR IRON COMPANY Edge Moor, Delaware

EDGE MOOR Water Tube BOILERS

STRAIGHT AND BENT TUBE TYPES—WATER WALLS—AIR PREHEATERS



Charts showing the amount of steam used in the steel mill. These show clearly the typical steel mill load with its wide fluctuations. Also they show during the high load period the steam flow was beyond the limit of the steam meter.

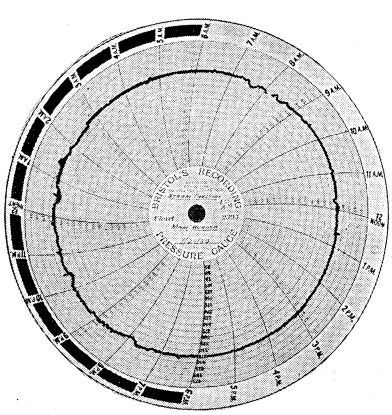
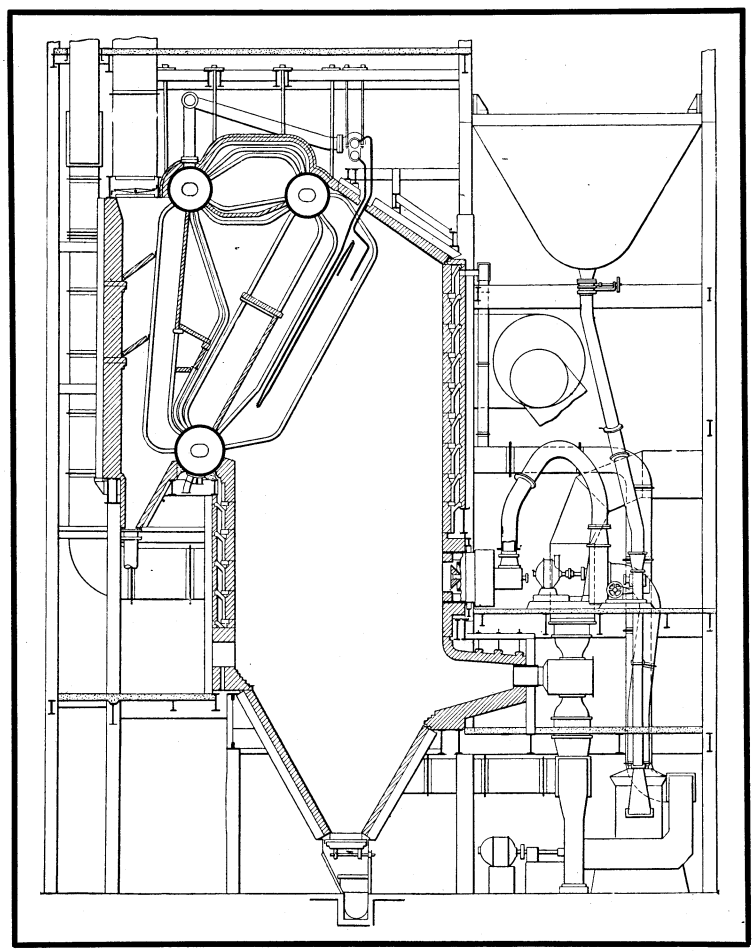


Chart showing how closely the steam pressure has been held regardless of the wide fluctuations in steam flow.

RAYMOND ROLLER MILLS

for Direct Fired Units



In the Pittsburgh district a large steel company is operating direct fired pulverized fuel units with Raymond Roller Mills. This combination handles the widely fluctuating steel mill load with surprising ease, as the speed of the mill, the mill exhauster and feeder, are automatically controlled and there is no variation in the fineness of the fuel fed to the furnace.

Combustion Engineering Corporation equipment in this installation includes: 4 three drum Ladd boilers of 14,250 sq. ft. of heating surface each, 4 Lopulco Direct Fired Pulverized Fuel Systems and 2 Raymond 4 ton Roller Mills for each boiler.

COMBUSTION ENGINEERING CORPORATION

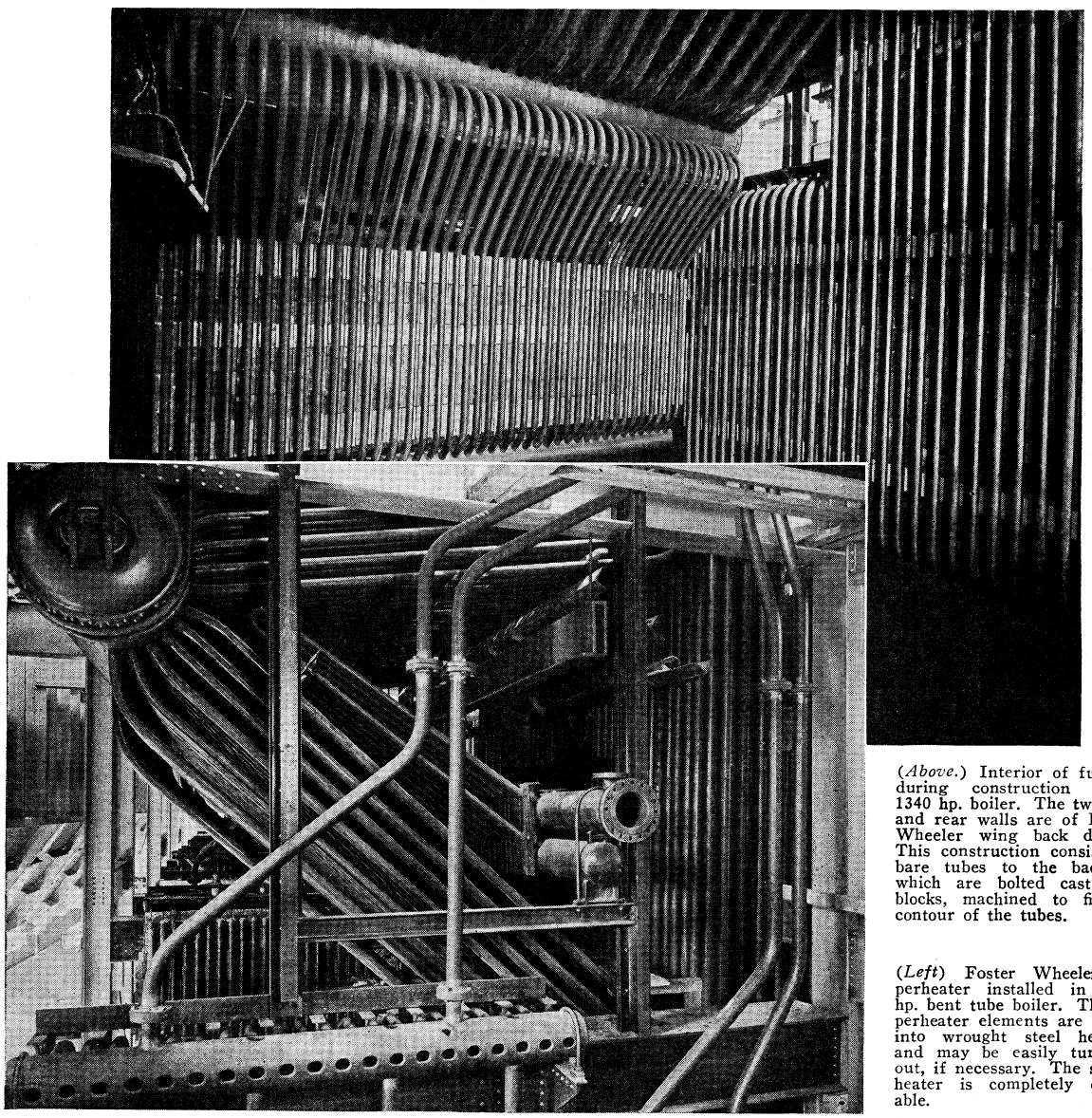
200 Madison Avenue New York, N. Y.

BOILERS - PULVERIZED FUEL EQUIPMENT - STOKERS
WATER-COOLED FURNACES - AIR-PREHEATERS

Steam Generators for

Four steam generating units for efficient operation with low grade fuel are shown in the accompanying photographs. The equipment was furnished complete by Foster Wheeler under a single contract, thus providing co-ordinated construction and unit responsibility for the entire installation.

The units provide large steam capacity—a high degree of flexibility and quick, easy control of combustion, from minimum to maximum ratings. The steam generator contract includes 1340-hp. boilers, water-cooled furnaces, superheaters, air preheaters, fuel pulverizers, settings, ducts, etc. Superheated steam is supplied at



(*Above.*) Interior of furnace during construction below 1340 hp. boiler. The two side and rear walls are of Foster Wheeler wing back design. This construction consists of bare tubes to the back of which are bolted cast iron blocks, machined to fit the contour of the tubes.

(*Left*) Foster Wheeler superheater installed in 1340 hp. bent tube boiler. The superheater elements are rolled into wrought steel headers and may be easily turbined out, if necessary. The superheater is completely drainable.

AERO UNIT COAL PULVERIZERS
AIR HEATERS CENTRIFUGAL PUMPS
CONDENSERS COOLING TOWERS
ECONOMIZERS EVAPORATORS
EXPANSION JOINTS FEED WATER HEATERS

FOSTER

Low Grade Fuels

a pressure of 225 lbs. per sq. in. when evaporating 117,000 lbs. of water per hour.

The Aero unit system of firing pulverized fuel delivers the powdered coal directly to burners placed in the front walls of the furnaces. The sensitive control of the Aero machines makes the system readily adaptable to automatic regulation. Foster Wheeler water walls of wing back construction occupy the two side and rear furnace walls. They permit continuous operation at high ratings without damage to brickwork.

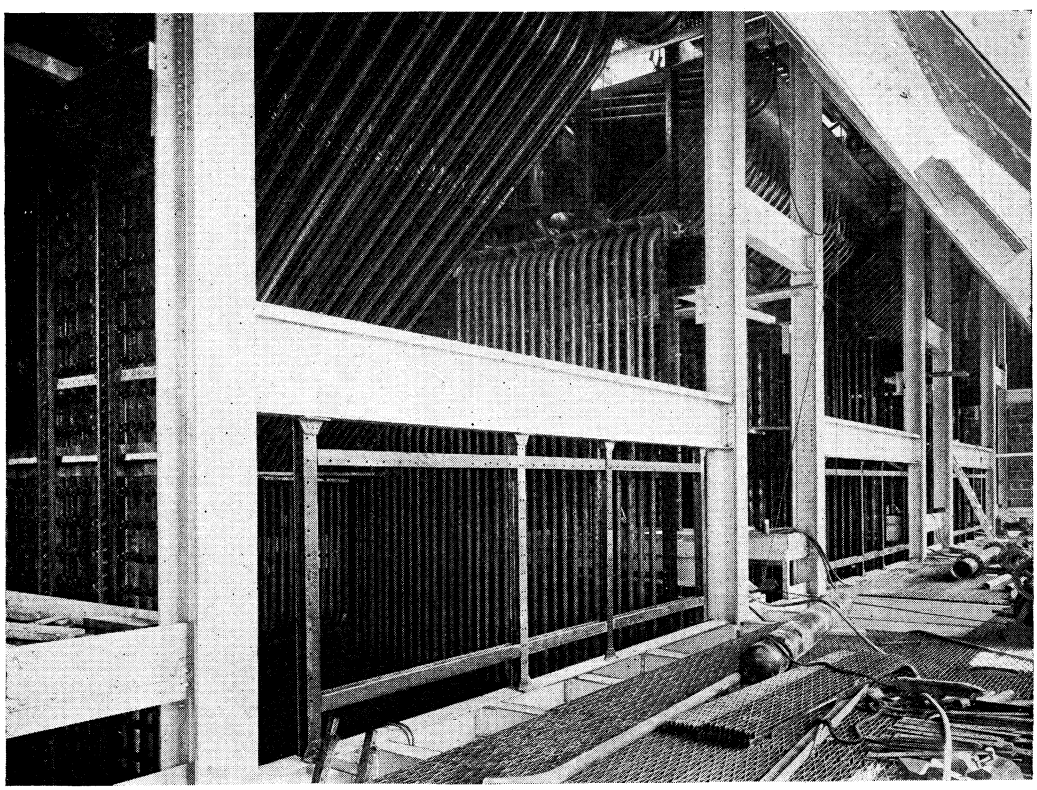
Foster Wheeler air preheaters of the tubular type are used. They are compactly built into the rear wall of the boiler and replace brickwork. Efficient combustion is provided by supplying the furnace with air at 419 deg. F. especially when using fuels of high moisture content.

FOSTER WHEELER CORPORATION

165 Broadway, New York, N. Y.

Foreign Associates—
Foster Wheeler Limited: London, England.
Societe Anonyme Foster Wheeler: Paris, France.
Foster Wheeler Limited: Toronto-Montreal, Canada.

Branches in Principal Cities



General view of the 1340 hp. steam generating units, under construction. Pulverized fuel firing, water cooled furnaces, superheaters and air preheaters assure the efficient operation of these units when using low grade fuels.

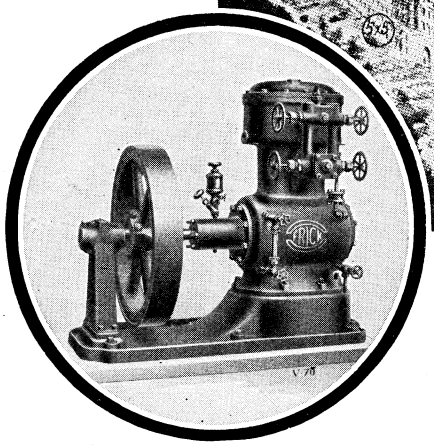
WHEELER

FRACTIONATING TOWERS HEAT EXCHANGERS
STEAM JET AIR PUMPS SUPERHEATERS
TUBE STILLS VACUUM PUMPS
WATER COOLED FURNACE SURFACES
BRASS AND COPPER TUBING AND PIPE

TRADE FRICK MARK

The Refrigerating Machine That Made Refrigeration Dependable

will give the same efficient refrigerating service in the Department of Commerce Building that it has shown in many older and very exacting cases. Eight separate Frick plants will cool the drinking water, hold proper temperatures in the storage rooms, and condition the air.



Department of Commerce Bldg., Washington, D. C.

Each of the machines on the eighth floor is a Combined Unit, connected to an open-type drinking water cooler. The 7 x 7 machine furnishes cold water, through a type M S cooler, for the air conditioning system. Ten rooms, attached to the restaurant kitchen, are refrigerated by the 5 by 5 machine in the basement, using a multipass brine cooler and galvanized box coils.

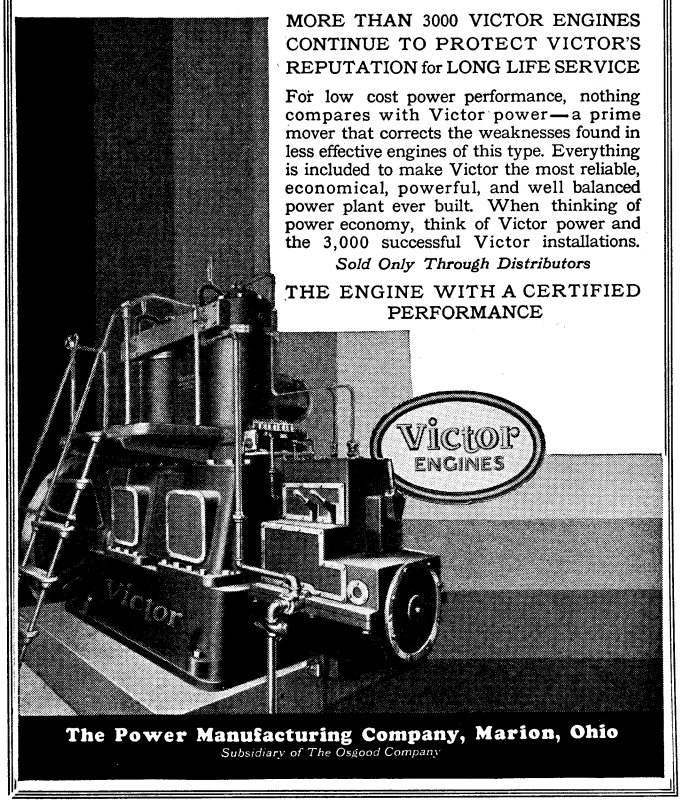
Branch offices and Distributors in 80 principal cities.

Frick Company
WAYNESBORO, PA., U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Send for copy of Ice and Frost Literature.

Victor

SOLVES THE POWER PROBLEMS OF INDUSTRY



MORE THAN 3000 VICTOR ENGINES CONTINUE TO PROTECT VICTOR'S REPUTATION for LONG LIFE SERVICE

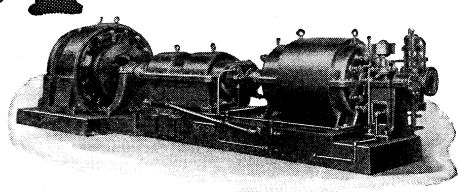
For low cost power performance, nothing compares with Victor power—a prime mover that corrects the weaknesses found in less effective engines of this type. Everything is included to make Victor the most reliable, economical, powerful, and well balanced power plant ever built. When thinking of power economy, think of Victor power and the 3,000 successful Victor installations.

Sold Only Through Distributors

THE ENGINE WITH A CERTIFIED PERFORMANCE

The Power Manufacturing Company, Marion, Ohio
Subsidiary of The Osgood Company

MOORE



Moore non-condensing turbo generator unit

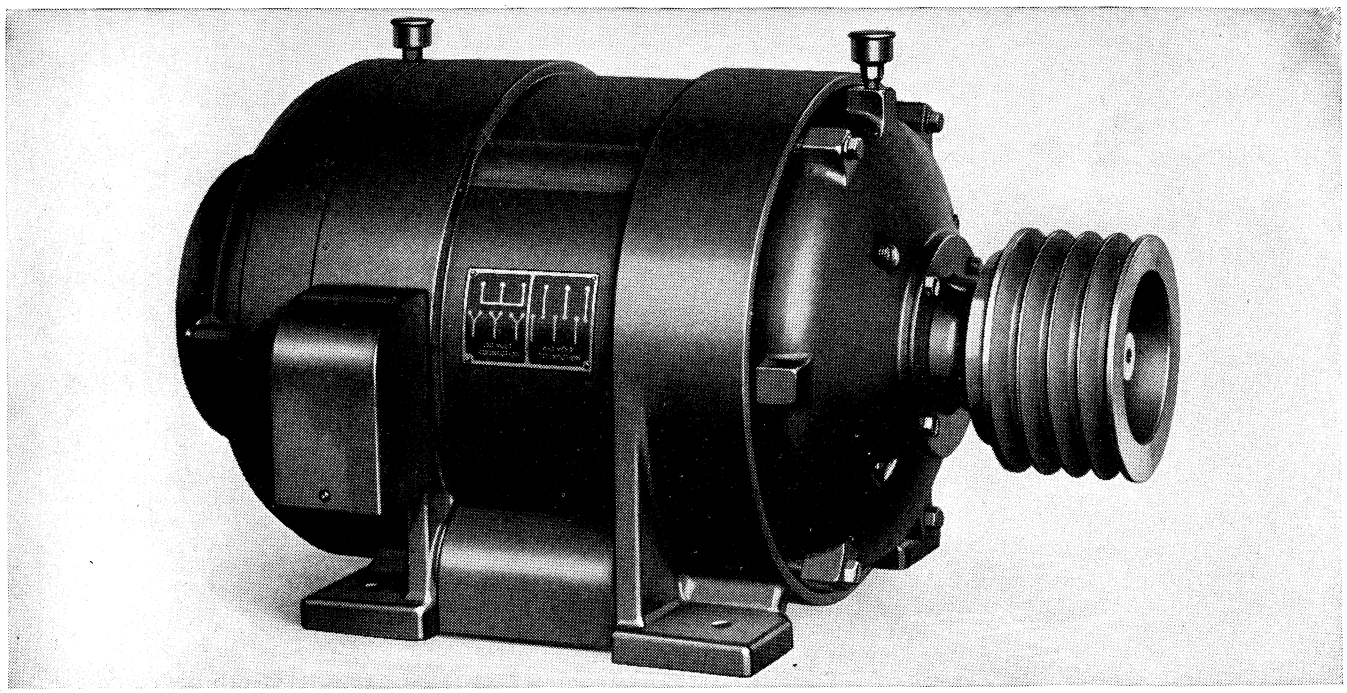
Steam Turbines Centrifugal Pumps Reduction Gears

MOORE STEAM TURBINE CORPORATION
WELLSVILLE, N. Y.

WACHS VERTICAL ENGINES

Used in leading industrial and power plants throughout the country, such as Central State Hospital, Indianapolis, Ind.; U. S. Naval Training Station, Great Lakes, Ill.; Goodyear Tire and Rubber Co., Akron, Ohio; and Washington University, St. Louis, Mo. Wachs Engines insure absolute dependability and economy under all conditions of auxiliary drives. Write for complete data on Wachs service.

THE E. H. WACHS COMPANY
1535 Dayton St., Chicago, Ill.



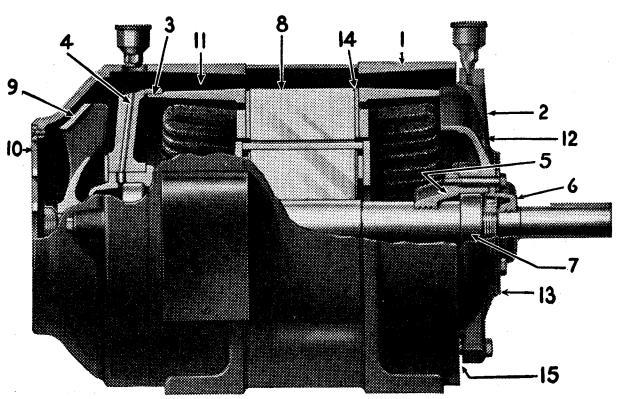
Safeguarded—

against dust, dirt, acid fumes, or moisture

—those factors that tend to shorten the life of windings — the Allis-Chalmers, totally enclosed, fan-cooled motor is ideally suited for operation in chemical plants, foundries, cement plants, crushing plants, mining and coal preparation. Being weather-proof, it is suitable for outdoor service.

Important Features

1—Cast steel end frames in combination with solid bearing housings (No. 2) provide complete enclosure without the use of sheet metal or other auxiliary parts.
2—Cast iron bearing housing serves also as end closure fitted to end frames with long rabbet fit (No. 3). Removable without exposing the bearings.
3—Rabbet fit forms a tight joint between end closure and stator frame.
4—Compression cup and grease duct, an integral part of housing assembly.
5—Bearing cartridge remains on shaft when motor is dismantled.
6—Cap secured to cartridge by screws prevents exposure of bearing and lubricant when rotor is removed.
7—Bearings of standard metric dimensions of medium series, secured by lock nut.
8—Stator and rotor laminations of silicon steel assure minimum core loss.
9—Cast aluminum fan, balanced, keyed and locked on shaft, designed for strength and efficient windage.
10—Fan housing with its grid cover completely isolates fan for safety.
11—Unobstructed air passage made shallow to increase air velocity over cooling surfaces.
12—Flush type pipe plugs for inspection of air gap.
13—Clamping ring.
14—Stator teeth supported by punchings of heavy plate steel.
15—Space for inserting a pinch bar to pry loose the bearing housings.



Sectional View Illustrating the Compact Design, Sturdy Mechanical Construction, and Accessibility.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

SELF-RELIANT AND DEPENDABLE

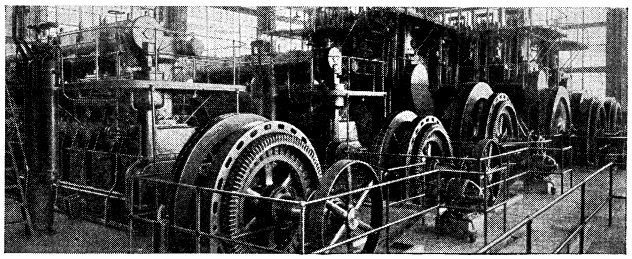
Distant location and bad water supply do not hinder a Diesel power plant

THE pumping station shown below is located in an out of the way place in Missouri where water is scarce, where fuel must be brought from a distance, and where repair facilities are a long way off, but the three 600-hp. McIntosh & Seymour Engines work right along with the same dependability and almost the same overall plant economy as though everything was favorable.

First of all, McIntosh & Seymour Engines are so simple and ruggedly built that other attention than can be given easily right in the plant is seldom if ever required.

Second, as the fuel is easily handled and weighs but one-third to one-sixth as much as coal that would produce an equal amount of power in a steam plant, carting and storing a whole season's supply to avoid shortage in time of labor troubles or snow-bound roads not only involves no hardship, but is actually an advantage as all the fuel can be bought and stocked during the low-price season.

Third, the very little water required for cylinder jacket cooling is insignificant in comparison with the large amount used for boiler and condenser operation in a steam plant. If the water supply is bad, a simple closed system circulating a small amount of clean water keeps the inner jacket walls in perfect condition, while water that could not be used in boilers is entirely satisfactory for the heat transfer coils or cooling equipment.



4450-B.hp. McIntosh & Seymour Deisel Engine plant. Started in 1923 with two 600-b.hp. units and one 750-b.hp. unit, and enlarged in 1926 by adding two 1250-b.hp. units. Selection of the two latter for more than doubling station capacity after 3-year experience with earlier units is good evidence of the superiority of McIntosh & Seymour Engines.

That McIntosh & Seymour Engines give excellent service regardless of location and tough operating conditions is proven by Mexican, West Indian and South American stationery installations and by installations driving ships and ship auxiliaries all over the world. We seldom hear from these foreign plants from one year's end to the next, and usually it is with words of praise for the efficient, economical and care-free service.

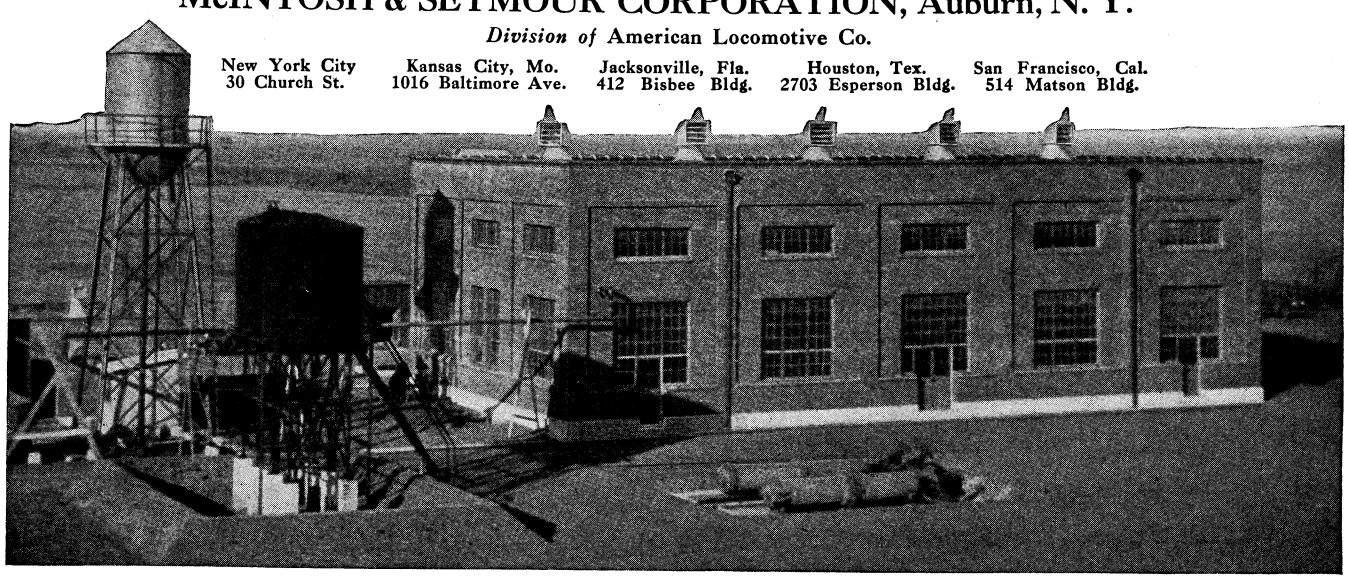
If your plant is handicapped by obsolete, inefficient steam units, high fuel costs, bad water, excessive maintenance, inadequate or uncertain output, let our Engineers submit Diesel costs and performance guarantees. At least, write for McIntosh & Seymour Bulletins.

McINTOSH & SEYMOUR DIESEL ENGINES

McINTOSH & SEYMOUR CORPORATION, Auburn, N. Y.

Division of American Locomotive Co.

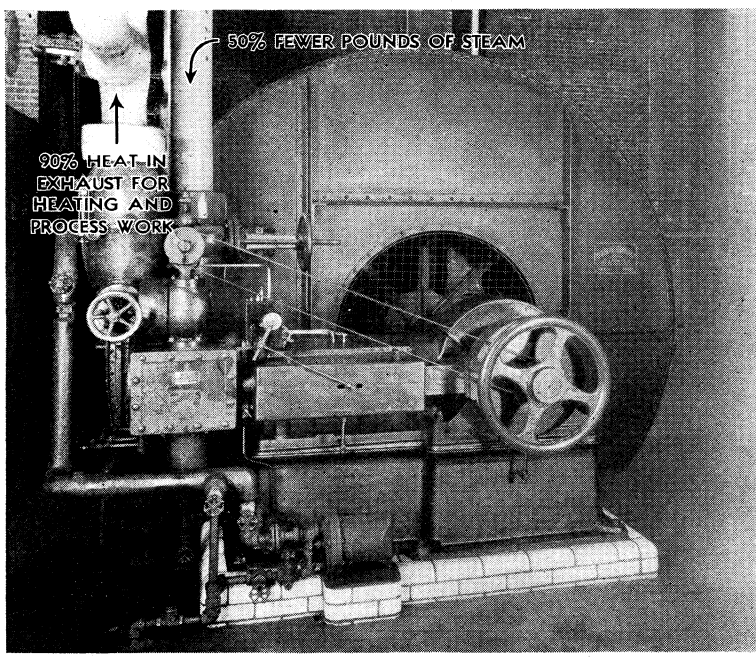
New York City 30 Church St. | Kansas City, Mo. 1016 Baltimore Ave. | Jacksonville, Fla. 412 Bisbee Bldg. | Houston, Tex. 2703 Esperson Bldg. | San Francisco, Cal. 514 Matson Bldg.



Steam Engine Drive . . . .

IS MORE ECONOMICAL AND MORE RELIABLE

This is the only drive that maintains low steam rates at all draft fan speeds.



One of four steam engines driving draft fans in a New York State Institution. Two have been installed ten years and two one year.

A few of the many users of Troy-Engberg Steam Engines

American Radiator Corporation
The Texas Company
Pet Milk Company
City of Detroit
Pennsylvania Railroad
Fisher Body Corporation
Berkey and Gay Furniture Company
Ohio State University
Weirton Steel Company
Sterling Wood Products Company

Most plants can use only a limited amount of exhaust steam. The *low steam rate* of steam engine drive at all fan speeds synchronizes best with exhaust requirements and results in *low power cost.*

Write today for guaranteed recommendations for your own plant. These will be sent you without obligation. Our engineers have a choice of vertical or horizontal engines up to 450 horsepower, suitable to all steam conditions. Write also for Descriptive Catalogs.

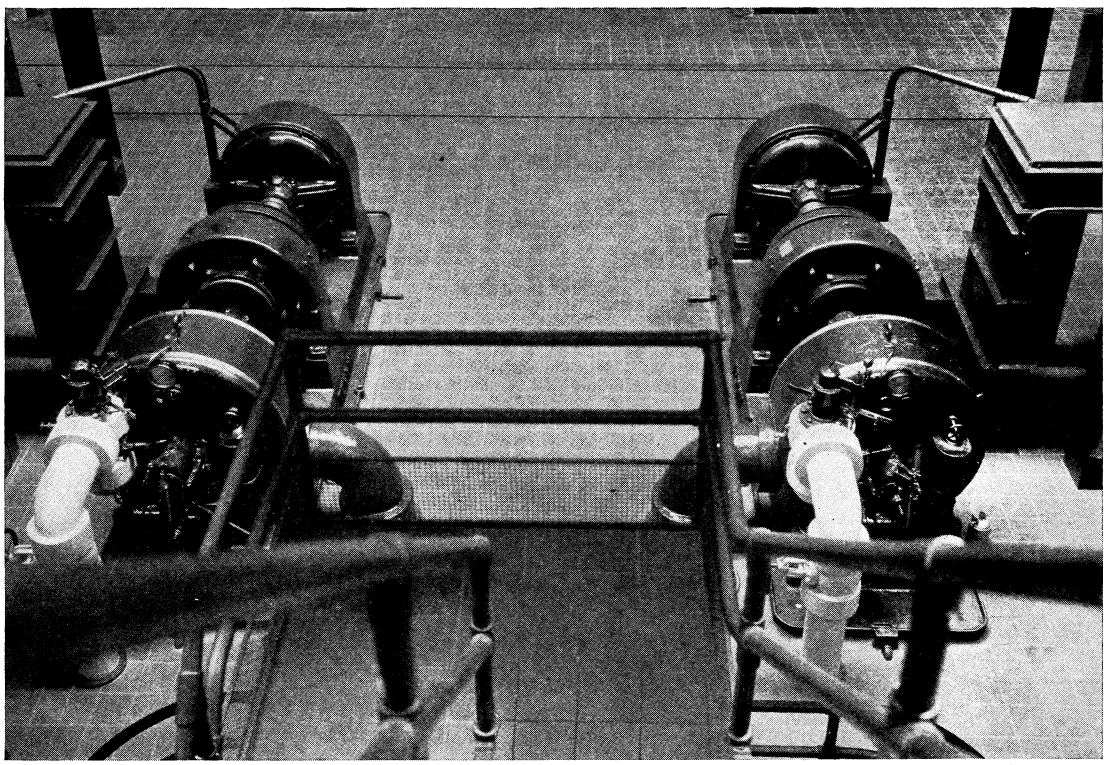
Many manufacturers of steam-driven equipment have standardized on Troy-Engberg Engines with lower cost and better performance.

TROY ENGINE AND MACHINE COMPANY
848 RAILROAD AVENUE « » TROY, PENNSYLVANIA « » U. S. A.

TROY - ENGBERG

Horizontal and Vertical Steam Engines « » Generating Sets « » Generators « » Switchboards

TERRY



Two 300KW Terry Duplex Exciters at High Bridge Sta., Northern States Power Co., St. Paul, Minn.

DEPENDABILITY AND HEAT BALANCE THRU TERRY DUPLEX DRIVE

The Terry duplex unit consists of a combined turbine and motor drive. It may be employed with any type of power plant auxiliary—exciters, boiler feeders, condenser circulators, etc.

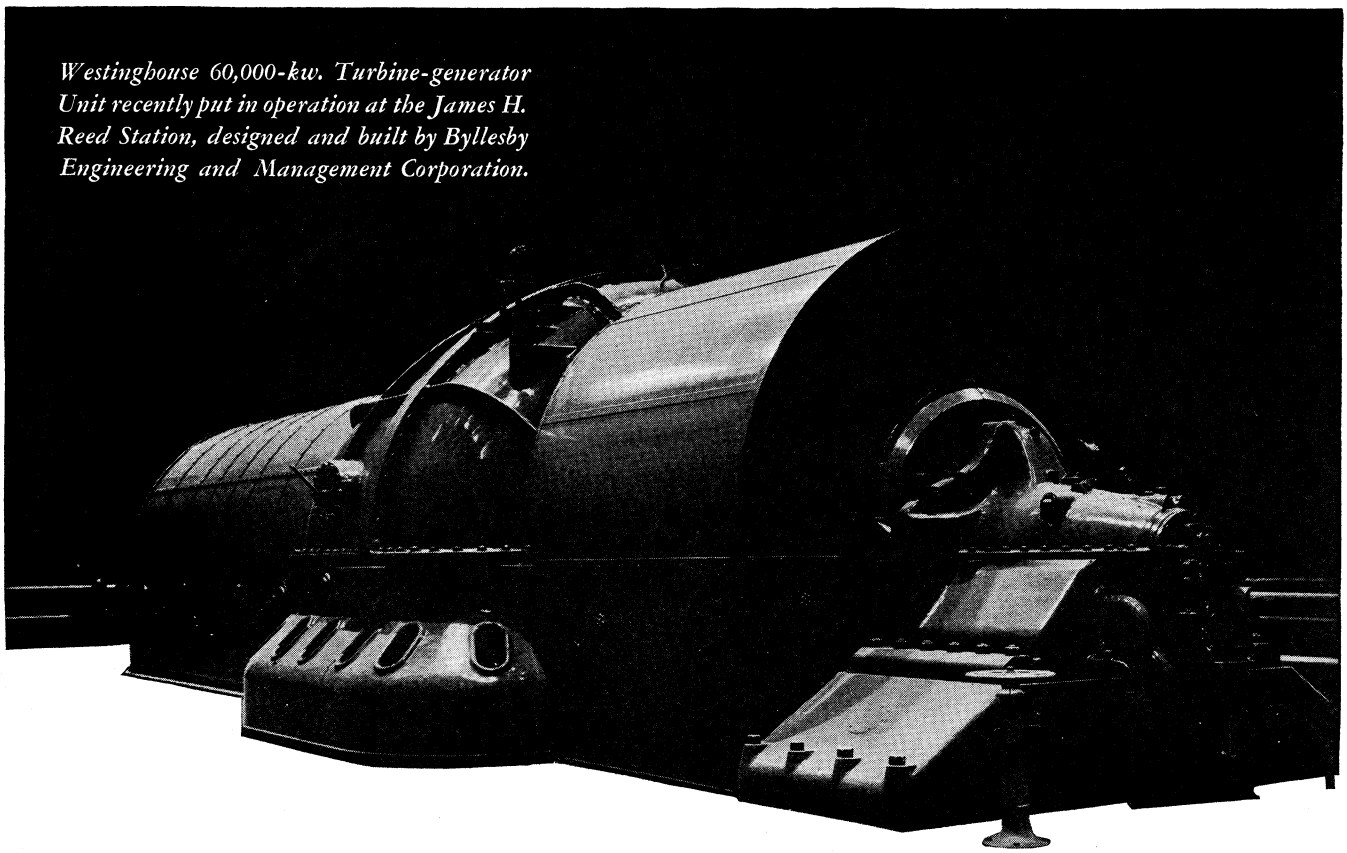
The unit is so arranged that if the current to the motor should fail the turbine would automatically take over the load of the driven machine. Continuity of service is therefore definitely assured.

At the same time it is possible, without interfering with the safety feature, to divide the load between the turbine and the motor. In this way the correct amount of exhaust steam can be obtained to secure a heat balance.

Hundreds of Terry turbine duplex drive units are now in service in many of the leading central stations and industrial plants of the country. Write for bulletin S-26 for full details.

The TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.
Steam Turbines - Gears - Shaft Couplings

T-1079



Westinghouse 60,000-kw. Turbine-generator Unit recently put in operation at the James H. Reed Station, designed and built by Byllesby Engineering and Management Corporation.

CHOSEN AGAIN

... by Duquesne Light Company

WITH the starting up of the new James H. Reed Station in Pittsburgh, the Duquesne Light Company put into service another Westinghouse Turbine-generator Unit.

Westinghouse units now in service for this company range in size from 1500 to 60,000 kw., with a total capacity of more than 450,000 kw.

The enduring reliability of Westinghouse Turbine-generators has been definitely established through years of successful performance since the initial installation for the Duquesne Light Company in 1907.

Years of experience, thorough engineering knowledge, complete manufacturing facilities, and expert service are the factors responsible for the dependable performance of Westinghouse turbines—performance which is helping the Duquesne Light Company to give the Pittsburgh district economical and reliable service.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse T 31692

WESTINGHOUSE ELECTRIC

TUNE IN THE WESTINGHOUSE PROGRAM OVER KDKA AND A NATION-WIDE N. B. C. NETWORK EVERY TUESDAY EVENING.

ALPHABETICAL INDEX TO ADVERTISERS

Air Preheater Corp., The.....119
Allen-Sherman-Hoff Co., The.....
.....Inside Back Cover
Allis-Chalmers Mfg. Co.....125
American Chimney Corp.....108
American Engineering Co.....117
American Pulverizer Co.....114
American Steel & Wire Co..... 93
Anderson Co., The V. D..... 10
Armstrong Machine Works..... 11
Ashton Valve Co., The..... 97
Atlas Valve Co..... 14

Babbitt Steam Specialty Co., Inc.... 97
Badenhausen Corp. 115
Bailey Meter Co..... 25
Ballard, Sprague & Co., Inc.....112
Bayer Co., The..... 29
Belfield Co., H.....104
Binks Mfg. Co..... 96
Borden Co., The..... 96
Bristol Co., The..... 20
Brown Instrument Co., The..... 23
Burt Mfg. Co., The..... 14

Cement-Gun Co., Inc.....109
Chaplin-Fulton Mfg. Co., The..... 14
Cochrane Corp. 19
Combustion Engineering Corp.....121
Condenser Service & Engr'g Co.... 20
Connelly Boiler Co., The D.....120
Connery & Co., Inc. 108
Crandall Pkg. Co..... 4
Crosby Steam Gage & Valve Co....105
Cutler-Hammer, Inc. 26

Darcoid Co. 4
Dart Mfg. Co., E. M.....105
Dearborn Chemical Co..... 28
De Laval Separator Co., The..... 14
De Laval Steam Turbine Co.....107
d'Este Co., Julian..... 92
Detroit Stoker Co.....116
Diamond Power Specialty Corp..... 12
Dixon Crucible Co., Joseph..... 9
Dust Recovering & Conveying Co..112

Economy Lubricating Co..... 4
Edge Moor Iron Co.....120
Elgin Softener Corp..... 28
Elliott Co. 3
Engineer Co., The.....108
Erie City Iron Works.....120
Ernst & Co..... 15
Everlasting Valve Co..... 97

Fairbanks, Morse & Co.....105
Fairfield Engineering Co.....112
Faulkner Refractories Co., J. A.....110
Fisher Governor Co..... 18
Foster Wheeler Corp.....122-123
Frederick Iron & Steel Co., The....106
Frick Co. 124
Fuller Lehigh Co.....111

Garratt-Callahan Co. 29
General Specialty Co., The..... 29
Goetze Gasket & Packing Co., Inc.. 5
Greene, Tweed & Co..... 4

Harbison-Walker Refractories Co...109
Hawk-Eye Compound Co..... 29
Henszey De-Concentrator Co..... 20
Hoppes Manufacturing Co., The.... 91
Huyette Co., Inc., The Paul B..... 15

International Combustion Engineering Corp. 121
International Nickel Co., Inc., The.. 24

Jenkins Bros. 102

Kaye & MacDonald, Inc..... 10
Kellogg Co., The M. W..... 87
Kelly Foundry & Mach. Co., The...114
Kennedy Valve Mfg. Co., The.....104
Kennedy-Van Saun Mfg. & Eng. Corp. 115
Keystone Lubricating Co..... 8

See pages 86, 88, 90 and 92 for Classified List of Products and Their Manufacturers.

Keystone Refractories Co., Inc.....109
Kieley & Mueller, Inc..... 20
Kingsford Foundry & Mach. Wks..106

Lecourtenay Co. 105
Leeds & Northrup Co..... 22
Liberty Mfg. Co..... 30
Limbert & Co., Geo. B..... 98
Lonergan Co., J. E..... 21
Lunkenheimer Co., The.....100

McGraw Hill Book Co., Inc..... 15
McIntosh & Seymour.....126
McLeod & Henry Co.....109

Manistee Iron Works.....106
Manzel Bros. Co..... 4
Master Mechanics Co..... 15
Meriam Co. 21
Metallo Gasket Co..... 4
Midwest Piping & Supply Co..... 97
Mohawk Water Treatment Co., The 29
Moore Steam Turbine Corp.....124

Nash Engineering Co.....106
National Aluminate Corp..... 28
National Pipe Bending Co., The....108
Neemes Foundry, Inc.....114
Nicholson & Co., W. H..... 10
Northern Equipment Co..... 13

Peabody Engineering Corp.....115
Pennsylvania Crusher Co.....114
Pennsylvania Pump & Compressor Co. 105
Pierce Co., The Wm. B..... 29
Pittsburgh Piping & Equipment Co. 96
Plibrico Jointless Firebrick Co..... 27
Pope, Wm. A..... 97
Powell Co., Wm.....103
Power Mfg. Co.....124
Power Piping Co..... 97

Quigley Co. 109

Reliance Gauge Column Co., The... 14
Republic Flow Meters Co..... 21
Roto Co., The..... 29
Ruggles-Klingemann Mfg. Co.....104
Rust Engrg. Co., The.....112

Sarco Co., Inc..... 10
Sauerman Bros., Inc.....112
Scaife & Sons Co., Wm. B..... 28
Signboard Section 94-95
Sintering Machinery Corp..... 20
Smooth-On Mfg. Co..... 89
Springfield Boiler Co.....115
Squires Co., The C. E.....
.....Inside Front Cover
Standard Oil Co. (Indiana)..... 4
Stephens-Adamson Mfg. Co.....113
Stockham Pipe & Fittings Co..... 96
Strong-Scott Mfg. Co., The.....115
Sturtevant Co., B. F.....118
Superheater Co., The.....114

Taylor Instrument Companies..... 21
Terry Steam Turbine Co., The.....128
Timken Roller Bearing Co., The.... 85
Troy Engine & Machine Co.....127

Union Iron Works.....120

Vacuum Oil Co.....6-7
Victor Chemical Works..... 28
Vogt Mach. Co., Inc., Henry.....101

Wachs Co., The E. H.....124
Wailes Dove-Hermiston Corp..... 20
Walworth Co. .....Back Cover
Warren Steam Pump Co., Inc.....106
Watson & McDaniel Co..... 10
Westinghouse Elec. & Mfg. Co.....129
Wheeler Mfg. Co., C. H.....108
Wickes Boiler Co., The.....120
Williams Valve Co., The D. T..... 99
Wing Mfg. Co., L. J.....108
Worthington Pump & Machinery Corp. .....Front Cover

Yarnall-Waring Co. 16-17, 108

A Two Man Power Plant

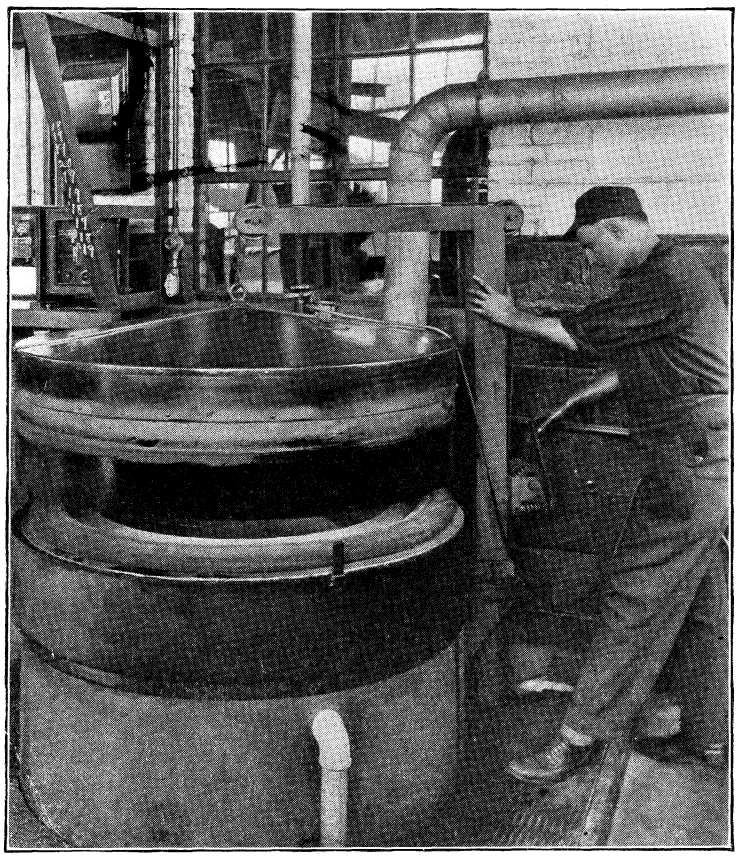
The new power plant of the General Steel Castings Co., Eddystone, Pa., consists of two boilers of 7197 sq.ft. heating surface fired by pulverized coal. The winter peak load runs 2,500,000 lbs. steam per day and in the summer this drops to around 100,000 lbs. per day. The normal operating force consists of only two men, and they are not overburdened. The Hydrojet System of Ash Handling contributes largely to the efficient operation of this plant. Ashes accumulate in hoppers beneath the furnaces and are removed by one man in about 10 minutes times, once or twice daily. A high velocity water stream feeds the ashes from the hopper into the trench beneath the floor, as shown in the round insert, while water from other nozzles in the trench conveys the refuse to fill, as shown in the rectangular insert. Due to the total enclosure of the system, ashes are removed without spillage, flying dust or water leakage; thus the labor in maintaining the plant clean is reduced to an absolute minimum. Sixty-four pages of valuable information are contained in our two new Hydrojet Catalogs. The Allen-Sherman-Hoff Co., 229 S. 15th St., Philadelphia. Offices in principal cities.

HYDRO JET

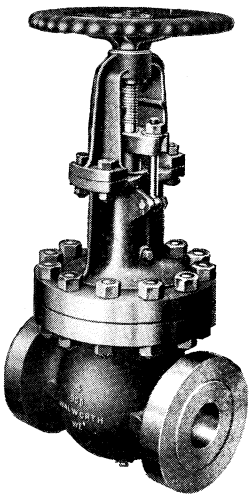
Nothing Moves but the Ashes

Pump your Ashes!

at GENERAL STEEL CASTINGS CO.



Nitriding Furnace in Walworth Shops



Series 900
Plain Yoke
O. S. & Y. Wedge Gate

for

POWER

NITRALLOY TRIM NOW AVAILABLE IN WALWORTH SIGMA STEEL VALVES

● Walworth Sigma Steel valves are now available with nitralloy trim for high-pressure, high-temperature steam service. ● Seat rings and discs forgings are processed in our own plants. ● Thus the hardest, most endurable heat-resisting material known becomes standard equipment in valves made of Walworth Sigma Steel—the steel of integrity, the development of which has set up a new standard of cast steel quality and performance.

● To Nitralloy—the patented Krupp steel treated with ammonia gas at high temperature in the specially constructed furnace shown in the photograph—we have assigned our trade name "Sigmalloy 352."

● For recommendation chart covering the use of Walworth Sigma Steel Valves, see our new Catalog 88.

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